eurofins | Expert Services

Kivimiehentie 4
FI-02150 Espoo, FINLAND
www.eurofins.fi/expertservices

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European Technical Assessment ETA 24/1158 of 27/12/2024

I General Part

Technical Assessment Body issuing the ETA	Eurofins Expert Services Oy
Trade name of the construction product	**CrossLam Kuhmo CLT**
Product family to which the construction product belongs	Solid wood slab elements to be used as structural elements in buildings
Manufacturer	**Oy CrossLam Kuhmo Ltd** Kivikatu 4 FI-88900 Kuhmo Finland www.crosslam.fi
Manufacturing plant	Oy CrossLam Kuhmo Ltd Kivikatu 4 FI-88900 Kuhmo Finland
This European Technical Assessment contains	20 pages including 3 Annexes which form an integral part of this assessment.
This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of	European Assessment Document 130005-00-0304, Solid wood slab element to be used as structural element in buildings.

II Specific Part

1 Technical description of the product

CrossLam Kuhmo CLT is a cross laminated timber element made of layers of spruce (Picea abies) or pine (Pinus sylvestries) boards that are glued together. Number of layers is 3, 5 or 7. In all the elements, the adjacent layers are arranged perpendicular (angle of 90°) to each other. The lay-up of the element is symmetric with respect to the plane defined by the centre line.

Each layer of laminations is comprised of strength graded planed sawn timber boards laid side by side. The thickness of the layer is as minimum 20 mm and as maximum 60 mm. The minimum width dimension of the boards is max(80 mm; 3t), when t is the thickness of the board. The individual boards of the layers may be non-structurally side-glued. The strength of the timber shall fulfil the requirements for class C24 according to EN 338. The individual boards are either full length or finger jointed according to the requirements of standard EN 16351 or EN 14080.

The maximum dimensions of the cross laminated timber element that can be manufactured are width 3,20 m and length 12,00 m. Thickness of the element is at least 60 mm and at maximum 300 mm.

The surfaces of CrossLam Kuhmo CLT may be covered with additional layers without load bearing function on one side. These layers are not part of this European Technical Assessment.

The application of wood preservatives and flame retardants is not subject to the European Technical Assessment.

2 Specification of the intended uses in accordance with the applicable EAD

2.1 Intended uses

CrossLam Kuhmo CLT is intended to be used as a structural or non-structural element in buildings and timber structures. The solid wood slab shall be subjected to static and quasi-static actions only.

CrossLam Kuhmo CLT is made of *Picea abies* or *Pinus sylvestris.* Durability against fungi of these species is of class 3 (pine heartwood) and 5 according to EN 350-2. Durability may be reduced by attack from insects such as long horn beetles, dry wood termites and furniture beetles in regions where these may be found.

The solid wood slab is intended to be used in service classes 1 and 2 according to EN 1995-1-1. Members which are directly exposed to the weather shall be provided with an effective protection for the solid wood slab element in service.

2.2 Working life

The provisions made in this European Technical Assessment are based on an assumed intended working life of the solid wood slab of 50 years[1].

2.3 Design

The European Technical Assessment only applies to the manufacture and use of the solid wood slabs. Verification of stability of the works including application of loads on the solid wood slab is not subject of this European Technical Assessment. Fitness for the intended use of the solid wood slab is given under the following conditions:

- Design of the solid wood slabs shall follow the Eurocode system (EN 1990, adequate parts of EN 1991, EN 1995-1-1 and EN 1995-1-2) and this ETA.
- Especially, the mechanical properties of CrossLam Kuhmo CLT as given in Annex 2 and design principles given in Annex 3 shall be used.
- Design of the cross laminated timber elements is carried under the responsibility of an engineer experienced in solid wood slab elements.
- Cross laminated timber elements are protected adequately against weather so that the conditions correspond to service classes 1 and 2.
- Cross laminated timber elements are installed correctly.

This European technical assessment is based on the assumption that all plans needed have been made correctly according to the regulations valid on the building site.

[1] This means that it is expected that when this working life has elapsed, the real working life may be, in normal use conditions, considerably longer without major degradation affecting the essential requirements of the works. The indications given as to the working life of the solid wood slab cannot be interpreted as a guarantee given by the producer or the assessment body. They should only be regarded as a means for the specifiers to choose the appropriate criteria for the solid wood slabs in relation to the expected, economically reasonable working life of the works.

2.4 Execution of construction works

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary. This advice should be followed by the user of the product.

It is assumed that the product will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

The completed building (the works) shall comply with the building regulations (regulations on the works) applicable in the Member States in which the building is to be constructed. The procedures foreseen in the Member State for demonstrating compliance with the building regulations shall also be followed by the entity held responsible for this act. An ETA for a solid wood slab element does not amend this process in any way.

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

Table 1. Basic requirements for construction works and essential characteristics

Basic requirement and essential characteristics	Performance
BWR 1. Mechanical resistance and stability[1)]	
Bending[2)]	3.1 Description, level
Tension and compression[2)]	3.1 Description, level
Shear[2)]	3.1 Description, level
Embedment strength	3.1 Description, level
Creep and duration of the load	3.1 Description, level
Dimensional stability	3.1 Description, level
In-service environment	3.1 Description
Bond integrity	3.1 Description
BWR 2. Safety in case of fire	
Reaction to fire	3.2 Class
Resistance to fire	3.2 Description, level
BWR 3. Hygiene, health and the environment	
Content, emission and/or release of dangerous substances	3.3 Description, class
Water vapour permeability – Water vapour transmission	3.3 Level
BWR 4. Safety and accessibility in use	
Impact resistance	3.4 Description
BWR 5. Protection against noise	
Airborne sound insulation	No performance assessed
Impact sound insulation of floors	No performance assessed
Sound absorption	No performance assessed
BWR 6. Energy economy and heat retention	
Thermal conductivity	3.5 Level
Air permeability	No performance assessed
Thermal inertia	3.5 Level

1) This characteristic also relates to BWR4

2) Load bearing capacity and stiffness regarding mechanical actions perpendicular to and in plane of the solid wood slab element.

3.1 Mechanical resistance and stability, BWR 1

The specifications regarding mechanical resistance and stability are given in Annexes 1 to 3. Resistances and stiffness values shall be calculated according to EN 1995-1-1 with the design principles given in Annex 2. Connection design and embedding strength values given in EN 1995-1-1 for solid timber shall be used with the design principles given in Annex 3. Tension perpendicular to the solid wood slab shall be avoided.

Mechanical resistance for each solid wood slab is given by the following method:

Method 1: Indication of geometrical data of the components and of properties of the materials and constituent products used

For the purposes of Method 1, all building components are described with regard to their components and their structure in Annex 1.

3.1.1 Bending

For values and design, see Annex 1 and 2 of this ETA.

3.1.2 Tension and compression

For values and design, see Annex 1 and 2 of this ETA.

3.1.3 Shear

For values and design, see Annex 1 and 2 of this ETA.

3.1.4 Embedment strength

Embedment strength is needed in design of connections, see Annex 3 of this ETA.

3.1.5 Creep and duration of the load

Creep and duration of load factors according to EN 1995-1-1 apply. In absence of specified values for cross laminated timber, values for plywood shall be used.

3.1.6 Dimensional stability

Tolerances of dimensions

Tolerances of dimensions are as follows:

Dimension	**Symbol**	**Tolerances**
Thickness (depth)	*h*	± 1 mm
Width	*b*	± 3 mm
Length	*l*	± 3 mm

Stability of dimensions

Three moisture content ranges at the time of shipping are possible: 10±2 %, 11±2 % or 12±2 %. Within one solid wood slab element only one of the specified moisture content ranges shall be applied. Tolerances are given in the specified mean moisture content: 10, 11 or 12 %.

Moisture content range shall be chosen according to the intended use so that inadmissible effects on performance and stability are avoided.

Thermal expansion

Normally, thermal expansion is not relevant for timber structures. Thermal expansion coefficients as given in EN 1991-1-5, Annex C Table C1, shall be used when needed.

3.1.7 In-service environment

See 2.1 of this ETA.

3.1.8 Bond integrity

Bond integrity fulfils the requirements of the EAD 130005-00-0304.

3.2 Safety in case of fire, BWR 2

3.2.1 Reaction to fire

In accordance with Commission Decision 2003/43/EC the solid wood slab elements covered by this European technical assessment for use as wall, roof, ceiling and special construction components comply with Euroclass D-s2,d0 according to EN 13501-1. The boundary conditions stated in the commission decision have to be attended for this classification. Provision for this classification is that possible surface treatments do not essentially change the behavior in fire.

Note: A European reference fire scenario for façades has not been laid down. In some Member States, the classification of the solid wood slabs according to EN 13501-1 might not be sufficient for the use in façades. An additional assessment of the solid wood slabs according to national provisions (e.g. on the basis of a large scale test) might be necessary to comply with Member State regulations, until the existing European classification system has been completed.

3.2.2 Resistance to fire

Resistance to fire can be calculated on the basis of EN 1995-1-2 and the strength values given under clause 3.1. For tightly butted boards (no gaps between adjacent boards), design charring rate for one-dimensional charring under standard fire exposure β_0 is 0,65 mm/min and design notional charring rate under standard fire exposure β_n is 0,7 mm/min.

The charring rates shall be used in the simplified bilinear model of clause 3.4.3 (Surface of beams and columns initially protected from fire exposure) of EN 1995-1-2 including the tabulated multiplication factors of the clause to determine the charring depth according to time requirements, considering clause 4.2.2 (Residual cross section method) of EN 1995-1-2. For the application of the simplified bilinear method, it should be highlighted that the fire exposed lamella shall be considered as a protective cladding of the subsequent lamella. Analogously, this procedure also applies to walls and floors/roofs.

3.3 Hygiene, health and environment, BWR 3

3.3.1 Content, emission and/or release of dangerous substances

No recycled wood has been used in the manufacturing of the solid wood slab. The formaldehyde potential class of the products glued with the polyurethane adhesive used in the manufacturing is classified to be E1.

The class of release of formaldehyde is E1 may be declared according to standard EN 13986 without testing, since no formaldehyde containing materials have been added to the solid wood slabs.

The manufacturer has not declared that CrossLam Kuhmo CLT would contain other dangerous substances.

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 also to be complied with, when and where they apply.

3.3.2 Vapour permeability – Water vapour transmission

Water vapour resistance factor μ for solid wood slab is 50.

3.4 Safety and accessibility in use, BWR 4

3.4.1 Impact resistance

Soft body resistance is assumed to be fulfilled for walls with a minimum of 3 layers and minimum thickness of 60 mm.

3.5 Energy economy and heat retention, BWR 6

3.5.1 Thermal conductivity

The design value of thermal conductivity to be used in design calculations of the solid wood slab is λ = 0,12 W/(mK). This value can be used in thermal resistance calculations according to EN ISO 6946.

3.5.2 Thermal inertia

The design value of thermal inertia to be used in design calculations of the solid wood slab is c_p = 1600 J/(kg K).

4 Assessment and verification of constancy of performance (hereinafter AVCP) system applied, with reference to its legal base

According to the Decision 97/176/EC of the European Commission[2], as amended by 2001/596/EC[3], 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 provided for in the applicable EAD.

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Eurofins Expert Services Oy.

Issued in Espoo on December 27 2024
by Eurofins Expert Services Oy

Teuvo Lounakoski
Manager, structures

Ari Kevarinmäki
Leading Expert

[2] Official Journal of the European Communities L 73/19 of 14 March 1997

[3] Official Journal of the European Communities L 209/33 of 2 August 2011

ANNEX 1

DESCRIPTION AND PERFORMANCE OF CROSSLAM KUHMO CLT

1 Lay-ups of the solid wood slab

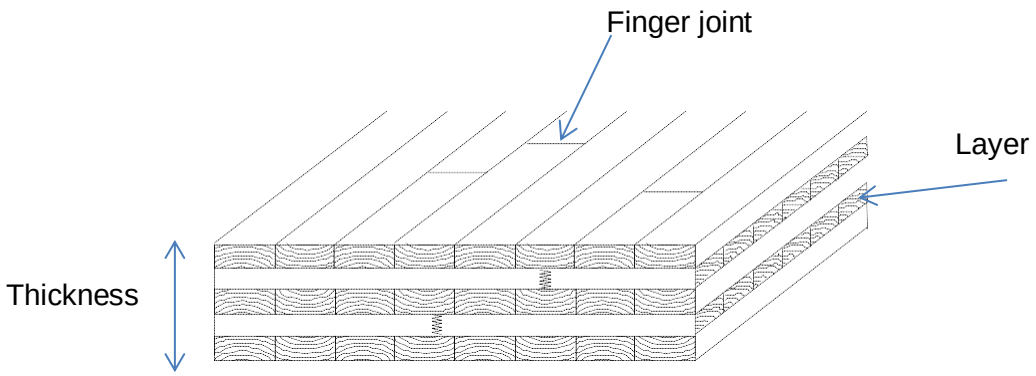

Figure 1. Principle structure of the solid wood slab (five layers)

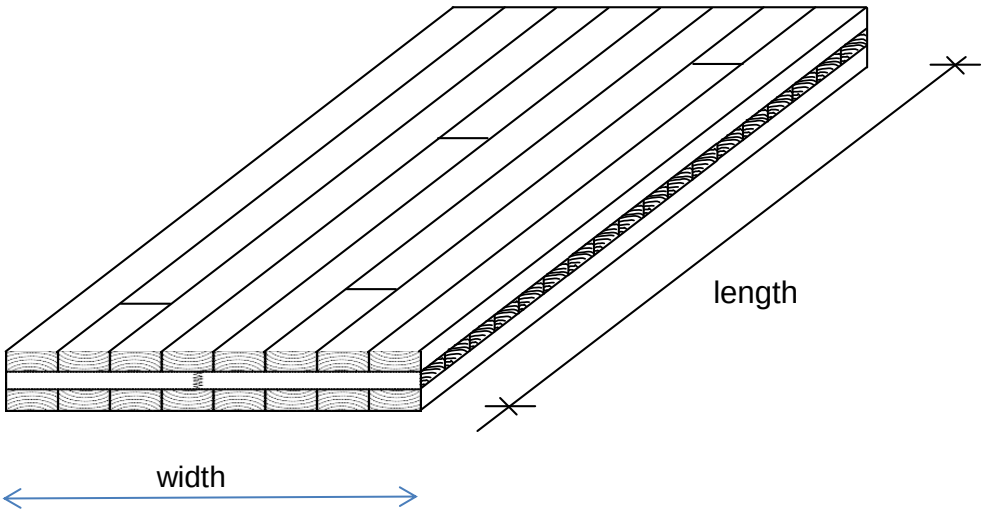

Figure 2. Solid wood slab element (three layers)

2 Dimensions and specifications

Table 2. Dimensions and specifications.

CrossLam Kuhmo CLT solid wood slab element		
Surface	-	Planed or sanded
Thickness	mm	60 – 300
Width	m	$\leq$ 3,20
Length	m	$\leq$ 12,00
Number of layers	-	3, 5 or 7
Boards (spruce or pine)		
Surface	-	Planed
Thickness *t*	mm	20 - 60
Minimum width	mm	$\geq$ max (80, 3*t*)
Gaps between adjacent boards		
• between every second board	mm	max 2
• 10 % of gaps	mm	max 5
Strength class of boards		C24
Finger joints		EN 16351 or EN 14080
Adhesive		EN 15425

3 Mechanical properties of the solid wood slabs

Table 3. Mechanical properties of the CrossLam Kuhmo CLT elements

1. Actions perpendicular to the solid wood slab		
	Standard	**Characteristic value N/mm²**
Bending strength $f_{m,k}$	EN 408	24
Compression strength $f_{c,90,k}$	EN 338	2,5
Shear strength perpendicular to the grain of the boards $f_{R,k}$	EN 408	1,2
Modulus of elasticity parallel to the grain of the boards $E_{0,mean}$	EN 408	12000
Modulus of elasticity perpendicular to the grain of the longitudinal boards $E_{90,mean}$	EN 338	370
Shear modulus parallel to the grain of the boards G_{mean}	EN 338	690
Shear modulus perpendicular to the grain of the boards $G_{R,mean}$	EN 408	50
2. Actions in plane of the solid wood slab		
Bending strength $f_{m,k}$	EN 408	24
Compression strength $f_{c,0,k}$	EN 338	21
Tension strength $f_{t,0,k}$	EN 338	14,5
Tension strength $f_{t,90,k}$	EN 338	0,4
Shear strength of the gross cross section $f_{v,k}$	EN 408	as given in Tables 4a and 4b
Modulus of elasticity parallel to the grain of the longitudinal boards $E_{0,mean}$	EN 408	11500
Shear modulus G_{mean}	EN 408	500
3. Actions generally		
For references regarding the calculation, see Annexes 2 and 3. National regulations shall be followed.		
Use of fasteners	According to EN 1995-1-1, for further details see Annex 3	

Table 4a. Characteristic shear strength values for edgewise loading of CrossLam Kuhmo CLT L-panels. In manufacturing of L-panels, the lamellas of cover layers are parallel to the length direction of the production line.

Product Id.	*L*	*C*	*L*	*C*	*L*	*C*	*L*	$f_{v,k}$ (N/mm^2)
	(mm)							
L3-60-20	20	20	20					2,67
L3-70-20	20	30	20					3,24
L3-80-20	20	40	20					3,50
L3-80-30	30	20	30					2,00
L3-90-20	20	50	20					3,50
L3-90-30	30	30	30					2,50
L3-100-30	30	40	30					3,13
L3-100-40	40	20	40					1,60
L3-110-30	30	50	30					3,50
L3-120-40	40	40	40					2,50
L3-130-50	50	30	50					1,85
L3-140-50	50	40	50					2,20
L3-160-60	60	40	60					2,00
L3-180-60	60	60	60					2,50
L5-100-20	20	20	20	20	20			3,20
L5-120-20	20	30	20	30	20			3,50
L5-120-30	30	20	20	20	30			2,67
L5-130-30	30	20	30	20	30			2,46
L5-140-30	30	30	20	30	30			3,24
L5-140-40	40	20	20	20	40			2,29
L5-150-30	30	30	30	30	30			3,00
L5-160-40	40	20	40	20	40			2,00
L5-180-40	40	30	40	30	40			2,60
L5-200-40	40	40	40	40	40			3,00
L5-220-60	60	20	60	20	60			1,45
L5-240-40	40	60	40	60	40			3,50
L7-140-20	20	20	20	20	20	20	20	3,43
L7-180-30	30	20	30	20	30	20	30	2,67
L7-200-20	20	40	20	40	20	40	20	3,20
L7-220-40	40	20	40	20	40	20	40	2,18
L7-240-30	30	40	30	40	30	40	30	3,50
L7-260-30	30	40	40	40	40	40	30	3,50
L7-260-50	50	20	50	20	50	20	50	1,85
L7-280-40	40	40	40	40	40	40	40	3,21
L7-300-60	60	20	60	20	60	20	60	1,60

Table 4b. Characteristic shear strength values for edgewise loading of CrossLam Kuhmo CLT C-panels. In manufacturing of C-panels, the lamellas of cover layers are perpendicular to the length direction of the production line.

Product Id.	*C*	*L*	*C*	*L*	*C*	*L*	*C*	$f_{v,k}$ (N/mm^2)
	(mm)							
C3-60-20	20	20	20					2,67
C3-70-20	20	30	20					2,88
C3-80-20	20	40	20					2,71
C3-80-30	30	20	30					2,00
C3-90-20	20	50	20					2,68
C3-90-30	30	30	30					2,50
C3-100-30	30	40	30					2,34
C3-100-40	40	20	40					1,60
C3-110-30	30	50	30					2,32
C3-120-40	40	40	40					2,50
C3-130-50	50	30	50					1,85
C3-140-50	50	40	50					2,20
C3-160-60	60	40	60					2,00
C3-180-60	60	60	60					2,50
C5-100-20	20	20	20	20	20			3,20
C5-120-20	20	30	20	30	20			3,36
C5-120-30	30	20	20	20	30			2,67
C5-130-30	30	20	30	20	30			2,46
C5-140-30	30	30	20	30	30			2,88
C5-140-40	40	20	20	20	40			2,29
C5-150-30	30	30	30	30	30			3,00
C5-160-40	40	20	40	20	40			2,00
C5-180-40	40	30	40	30	40			2,60
C5-200-40	40	40	40	40	40			3,00
C5-220-60	60	20	60	20	60			1,45
C5-240-40	40	60	40	60	40			2,71
C7-140-20	20	20	20	20	20	20	20	3,43
C7-180-30	30	20	30	20	30	20	30	2,67
C7-200-20	20	40	20	40	20	40	20	3,20
C7-220-40	40	20	40	20	40	20	40	2,18
C7-240-30	30	40	30	40	30	40	30	2,93
C7-260-30	30	40	40	40	40	40	30	2,70
C7-260-50	50	20	50	20	50	20	50	1,85
C7-280-40	40	40	40	40	40	40	40	3,21
C7-300-60	60	20	60	20	60	20	60	1,60

ANNEX 2

DESIGN OF CROSSLAM KUHMO CLT ELEMENTS

1. Mechanical actions perpendicular to the solid wood slab

Stress distribution within the solid wood slab shall be calculated so that the shear deformation of the cross layers is taken into account.

For simply supported solid wood slabs with up to 5 layers, the stress distribution may be calculated according to EN 1995-1-1 as mechanically jointed beam where the value s_i/K_i is substituted by $h_i/(G\ b)$ with h_i = thickness of the cross layer, G = shear modulus of the cross layer (50 N/mm^2) and b = width of the cross layer.

For solid wood slabs with 7 layers, numerical solutions shall be used offered by computer programs taking into account the shear deformation of the cross layers.

For the design of solid wood slabs, the characteristic strength and stiffness values shall be taken from Annex 1.

For the bending design, only the stresses at the edges of the boards are decisive, axial stresses in the centre of the boards are not considered in the bending design.

In bending design the characteristic bending strength properties may be multiplied by a system strength factor k_ℓ

$$k_\ell = \min\begin{cases}1+0{,}025\cdot n\\1{,}2\end{cases}$$

where n = number of boards within a layer.

Tension loads perpendicular to the element shall be avoided.

2. Mechanical actions in plane of the solid wood slab

Stress distribution within the solid wood slab shall be calculated by taking into account only the boards which are oriented in the direction of the actions.

Shear stresses may be calculated with the total width of the solid wood slab.

For the design of solid wood slabs, the characteristic strength and stiffness shall be taken from Annex 1.

In bending design the characteristic bending strength properties may be multiplied by a system strength factor k_ℓ

$$k_\ell = \min\begin{cases}1+0{,}025\cdot n\\1{,}2\end{cases}$$

where n = number of longitudinal layers.

ANNEX 3

DESIGN OF CONNECTIONS WITH METAL FASTENERS

1. Design of connections with metal fasteners

1.1 General

The design rules given in this section amend the design rules for connections given in EN 1995-1-1. Face sides are the surfaces of the element parallel to the plane of element, edge sides are the surfaces perpendicular to the plane sides of the element.

1.2 Laterally loaded dowel type fasteners

Fasteners in the face side of the cross laminated timber

Embedment strength:

For nails, self-tapping screws, dowels and bolts in the plane side of cross laminated timber the embedment strength of solid timber may be used, depending on the characteristic density of the laminations of the cross laminated timber and on the angle between force and grain direction of the outer layer.

The following conditions should be fulfilled:

- diameter of nails $d \geq 4$ mm
- diameter of self-tapping screws $d \geq 6$ mm

Effective number of fasteners:

The effective number of fasteners may be taken as the actual number of fasteners:

$$n_{ef} = n \quad (1)$$

Minimum spacings, edge and end distances:

Minimum spacing of fasteners as well as the minimum values for edge and end distances are given in Table 5. Symbols used are clarified in Figure 3, where α is the angle between the load and the grain direction of the outer layers.

Table 5. Minimum spacings and edge and end distances for laterally loaded fasteners in face sides of CrossLam Kuhmo CLT.

Fastener	a_1	$a_{1,t}$	$a_{1,c}$	a_2	$a_{2,t}$	$a_{2,c}$
Nails	$(3 + 3\cos\alpha)d$	$(7 + 3\cos\alpha)d$	$6d$	$3d$	$(3 + 4\sin\alpha)d$	$3d$
Screws	$4d$	$6d$	$6d$	$2{,}5d$	$6d$	$2{,}5d$
Dowels	$(3 + 2\cos\alpha)d$	$5d$	$\max\begin{cases}4d\cdot\sin\alpha\\3d\end{cases}$	$3d$	$3d$	$3d$
Bolts	$\max\begin{cases}(3+2\cos\alpha)d\\4d\end{cases}$	$5d$	$4d$	$4d$	$3d$	$3d$

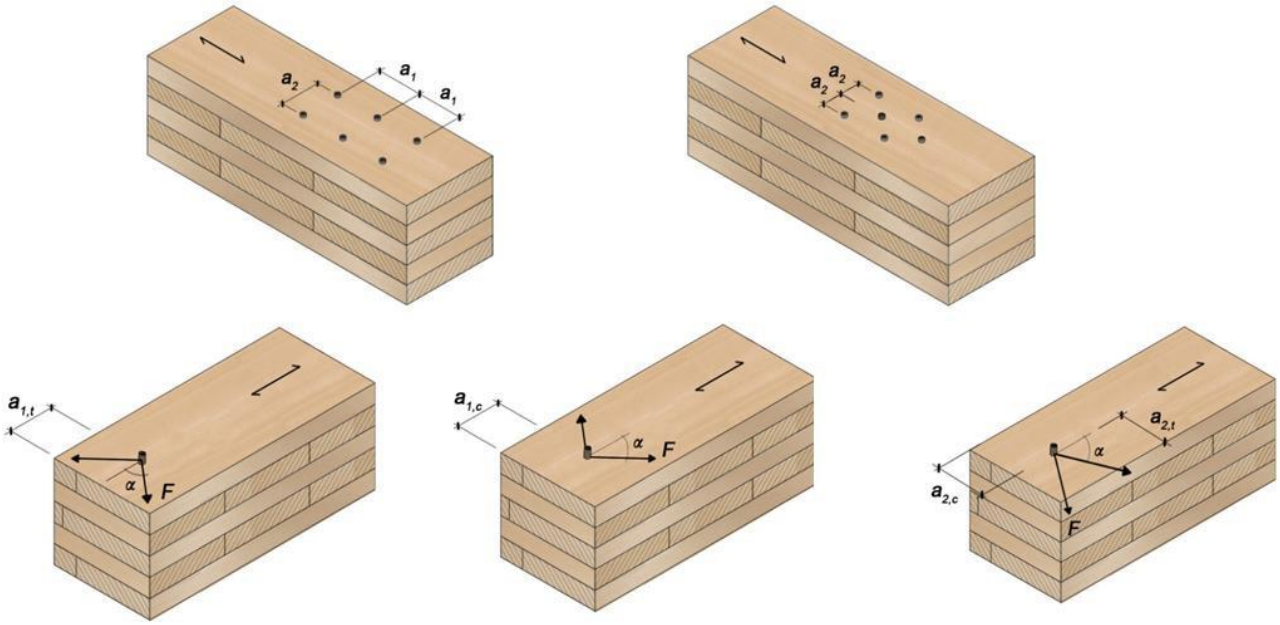

Figure 3: Definitions for the distances and spacings for the laterally loaded fasteners of face sides.

Fasteners in the edge side of the cross laminated timber

Only self-tapping screws may be used in the edge side connections.

Embedment strength

For connections in the edge of cross laminated timber, embedment strength of self-tapping screws with the diameter $d \geq 8$ mm can be calculated from equation:

$$f_{h,k} = 20d^{-0,5} \quad \text{in N/mm}^2 \qquad (2)$$

where d is the nominal diameter of the self-tapping screws in mm.

For actions perpendicular to the plane of the slab, the possibility of splitting caused by the tension force component perpendicular to the grain shall be taken into account. Connections with ratios h_e/h < 0,7 should be reinforced with fully threaded screws, when h_e is the loaded edge distance to the centre of the most distant fastener and h is the thickness of the cross laminated timber (see example in Figure 4).

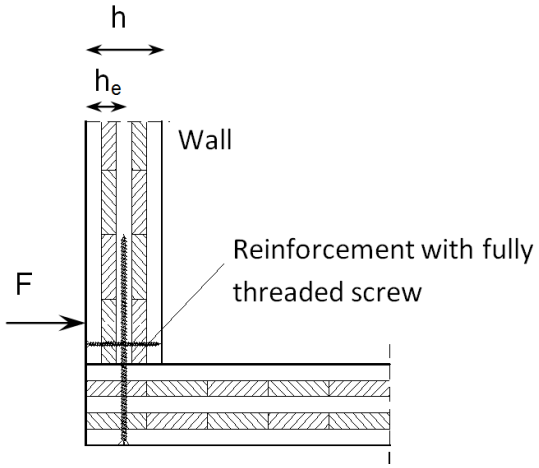

Figure 4. Reinforcement of connection area of cross laminated timber with fully threaded screws.

Effective number of fasteners:

The effective number of fasteners shall be determined in accordance with the rules for sawn timber.

Minimum spacings, edge and end distances:

For edge side connections, the minimum spacings, edge and end distances are given in Table 6. The required thickness for cross laminated timber and layers and required penetration length of screws are given in Table 7. The symbols for distances and dimensions are defined in Figure 5.

Table 6. The minimum spacings, edge and end distances for laterally loaded screws in edge of cross laminated timber.

Fastener	a_1	$a_{1,t}$	$a_{1,c}$	a_2	$a_{2,t}$	$a_{2,c}$
Self-tapping screws	10d	12d	7d	3d	6d	3d

Table 7. Requirements for edge side connections of cross laminated timber.

Fastener	Minimum thickness of the relevant layer h_i	Minimum thickness of the cross laminated timber h	Minimum penetration length of the fastener t_1 or t_2 [a)]
Self-tapping screws	d > 8 mm: 3d $d \leq$ 8 mm: 2d	10d	10d
[a)] t_1 Minimum penetration length of fastener in side member t_2 Minimum penetration length of fastener in middle member			

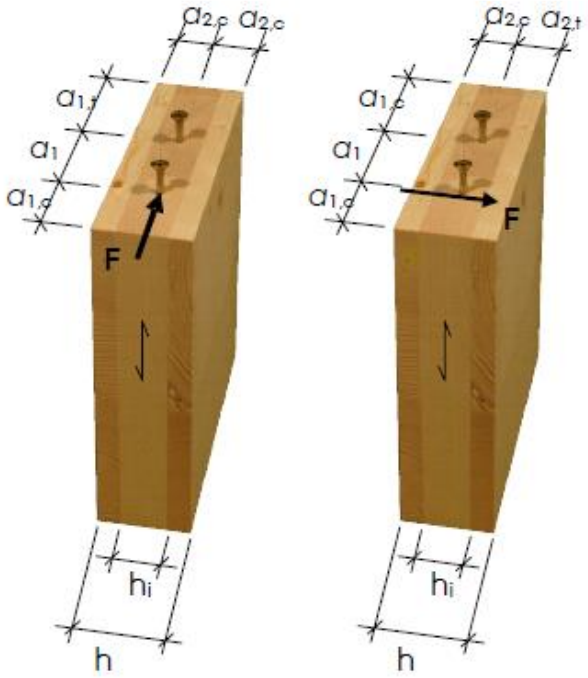

Figure 5. Definition of minimum spacings and distances for laterally loaded fasteners in the edge of cross laminated timber.

1.3 Axially loaded dowel type fasteners

Nails

Axially loaded nails shall be threaded. The characteristic withdrawal capacity for threaded nails in face sides of CrossLam Kuhmo CLT elements may be calculated as follows:

$$R_{ax,k} = 14\, d^{0,6}\, \ell_{ef} \qquad \text{in N} \tag{3}$$

where d is the nail diameter and ℓ_{ef} is the penetration length of the threaded part.

The following conditions should be fulfilled:

- there are at least two nails in a connection
- nail diameter $d \geq 4$ mm
- penetration length of the threaded part $\ell_{ef} \geq 8d$
- characteristic value of withdrawal strength declared for the nail corresponding to sawn timber of strength class C24, $f_{ax,k} > 6$ N/mm^2

Axially loaded self-tapping screws

Withdrawal resistance:

The characteristic withdrawal capacity for self-tapping screws in the plane sides or in the narrow sides of cross laminated timber may be calculated according equation (4).

$$R_{ax,k} = \sum_{i=1}^{n} f_{ax,i,k} \cdot \ell_{ef,i} \cdot d \qquad (4)$$

where

d = nominal diameter of the screw that is at least 6 mm for face connections and at least 8 mm for edge connections

$f_{ax,i,k}$ = characteristic withdrawal strength of screw in sawn timber of strength class C24 depending on the angle α_i between the screw axis and the grain direction of layer i

$\ell_{ef,i}$ = penetration length of the threaded part of the screw in layer i

n = number of penetrated layers.

The following conditions should be fulfilled:

- penetration length of the screw $\ell_{ef,i} \geq 4d$
- angle between screw axis and grain direction of timber $\alpha \geq 30°$
- screws parallel to the face surface of CLT shall be installed so that they are in whole within one single layer (screws shall not be installed in the joint between layers).

For the headside pull-through strength of the screw in CrossLam Kuhmo CLT, the value for sawn timber of strength class C24 may be used.