X-LAM – Cross-laminated timber

Large-format construction components
for roofs, ceilings and walls

TIMBER IN A NEW DIMENSION

DERIX

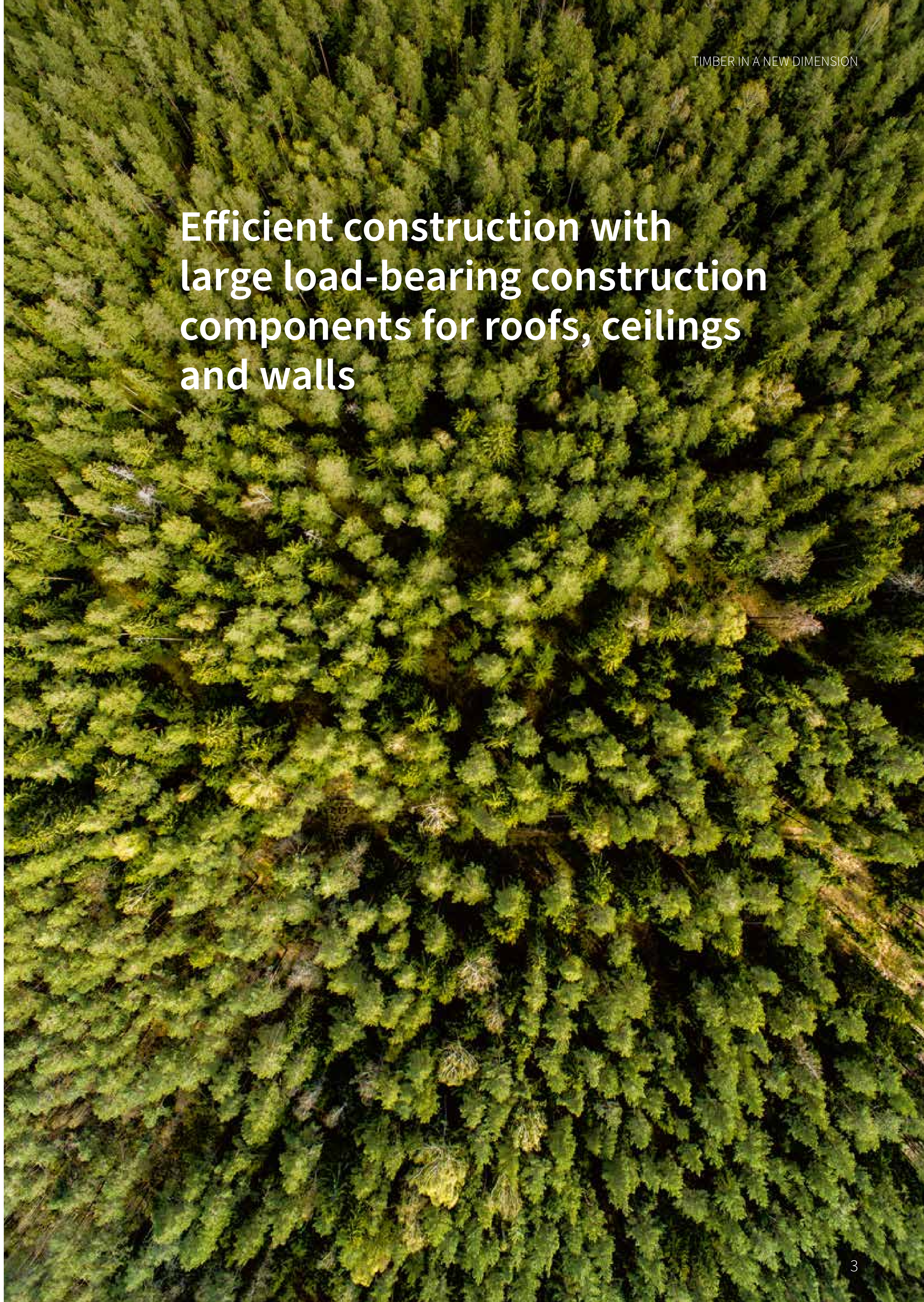
Building with X-LAM

As manufacturer and supplier of laminated products, we serve the whole spectrum of laminated timber construction. We see ourselves primarily as partners for architects, timber-construction companies and building contractors.

X-LAM is cross-laminated timber that combines the best properties of different materials as load-bearing plate or panel construction components. X-LAM is a solid material with a considerable load-bearing capacity. These prefabricated components are easy and fast to install on site – equally well for roofing, ceilings or walls. Cross-laminated timber consists of three or more layers of sawn timber glued together at right-angles. The innovative building material replaces brickwork and concrete, and filigree wideslabs, and complements timber-frame construction components.

Our services:

- Consulting
- Planning
- Structural calculation
- Production
- CNC processing
- Supply
- Assembly support services (if required)



Roof, ceiling, wall – all made from one material

CHANGE OF SHAPE

II to the panel 0.01 % per % of timber moisture change

⊥ to the panel 0.20 % per % of timber moisture change

Thermal conductivity λ:	0.13 W/(mK)
Specific heat capacity c:	1.61 kJ/(kgK)
Water vapour diffusion resistance μ:	20– 50

APPROVALS

ETA-11/0189

EEC conformity declaration

PEFC certificate (production sites Niederkrüchten and Westerkappeln)

At a glance

Board dimensions:

Length:	6.00 – 17.80 m
Width:	up to 3.50 m
Thickness:	up to 400 mm

Timber species / Strengh classes

Spruce:	C24
Moisture content:	10 % ± 2 %
Moulded density:	approx. 450 kg / m³

(other timber species and strength classes on request)

Glueing

GripPro-Plus adhesive based on melamine resin, approved according to DIN EN 301:2018. This next-generation adhesive contains NO declarable hazardous substances. With emission figures a tenth of permitted exposure limits, these values are equivalent to those for natural wood.

Cutting and Processing:

with 5-axis CNC portal machine,
to customer specifications

Computed burn rate:

0.65 mm / minute

Clear benefits

Benefits for planners

- European Technical Approval
- Individual design options
- Not limited to standard dimensions
- Large size
- High load-bearing capacity
- High level of fire protection
- Earthquake-resistant

Construction components made of X-LAM are cut to size and are not constrained to have standard dimensions. This gives freedom for individual design. The data needed for planning is given in the European Technical Approval (ETA) and can be applied to projects rapidly with our draft design program. Buildings made with X-LAM are advantageous, including in earthquake zones, because of their low mass and high strength.

Benefits for building contractors

- Pleasant room atmosphere
- Economical construction method
- High degree of prefabrication
- Short times for building and fitting
- Solid construction components
- Heat protection in summer
- Dimensionally stable

The natural building material wood is the preferred choice when there are high demands on a pleasant and comfortable atmosphere in the rooms. The high level of prefabrication results in fast building and assembly times, which makes the solid construction components very economical. Low thermal conductivity and high thermal protection in summer ensure comfortable living and save energy.

Benefits for the environmentt

- CO_2-neutral
- Excellent ecobalance
- Airtight and windproof
- PEFC certified

The raw material for making X-LAM is currently exclusively softwood. As a business certified by PEFC, we focus on sustainable, careful and responsible forestry. Compared to other solid construction methods, the manufacture and processing of X-LAM components requires only little energy and contributes to long-term CO_2 storage and so to minimising the greenhouse effect.

Nature meets high-tech – X-LAM in use

Feel-good rooms from moisture equilibrium

Timber can take up and release moisture - depending on the surrounding atmosphere. This property results in a very comfortable atmosphere in the room. It is natural that a change in moisture also brings a change in volume - swelling and shrinkage.
This is where the high-tech material, X-LAM, scores because this effect can be ignored in planning for normal applications. The transverse glueing of the boards together with the kiln drying of the lamellae to a timber moisture of 10 ± 2% minimises the change of volume. This value corresponds to the expected equilibrium moisture content during later use of the building.

This equilibrium property has an effect on the appearance of the surface. Mainly the outer layers of the X-LAM take up moisture during transport and the building phase, depending on the weather situation.

Careful equalization of the moisture preserves the appearance

The moisture content during construction must be adjusted gradually to the equilibrium moisture content of the later use by careful heating and ventilation. If the indoor climate becomes too dry because the room has been warmed up too fast, the surface of the X-LAM panels will release too much moisture, so that this effect cannot be compensated. Shrinkage cracks and gaps can then occur on the surface of the X-LAM components, especially in the area of the joints of the lamellae. To avoid uncontrolled stress cracks, the edges of the lamellae are not glued.

Timber is a natural and non-homogeneous construction material

Surface qualities can be precisely and reproducibly defined only to a limited extent. In cases of doubt, the surface quality should be inspected at the factory or in reference projects and agreed between the planner, manufacturer and builder.
Load-bearing components made of X-LAM are constructional components designed for structural use and carefully manufactured from an improved material. Subsequent apertures, notches, additional loads and other changes of the static system must always be agreed with the responsible structural engineer.

Nature meets high-tech – X-LAM in use

Treatment of visible surfaces

The requirements for the later surface quality must be determined at the planning phase. Construction components of X-LAM have the advantage that they can be the finished surface at the same time. In contrast to buildings where the surfaces are formed afterwards, a high level of quality in the shell construction phase is decisive for a perfect end result.

For visible surfaces we recommend:

- protection of the components from damage and dirt during transport and construction;
- minimising the uptake of water as far as possible (condensation-free covering, avoid entry of rain);
- rapid roofing and closing of the building;
- targeted agreement and guidance of the subsequent trades during the construction phase and demonstration of the material-specific properties;
- avoiding large changes in the room atmosphere;
- arranging the use of the building for standard atmospheres (i.e. 40 % to 60 % air humidity);
- allow for or obtain tenders for any required cosmetic reworking on the visible surfaces;
- coating the components with our BSH varnish as additional protection from moisture uptake and dirt during transport and assembly.

Rapid roofing will provide the best protection of visible surfaces from weathering effects.

Even with very careful manufacture and only small variations of moisture content, cracks and / or gaps between the lamellae cannot be entirely prevented because of the nature of the material. Coatings, particularly in bright colours, make the cracks and gaps more visible. We explicitly advise against allowing cost considerations to result in visible industrial quality instead of living-space quality.
For static construction components the outer layer thickness has an entirely beneficial effect on the load-bearing performance of the component. On the other hand, thicker lamellae tend to greater swelling and shrinkage, resulting in increased formation of cracks and / or gaps. A good compromise between structural and visual demands is to have lamellae up to 30 mm thick.

Surface quality: Optical requirements as needed

X-LAM is a natural product whose appearance varies. Wall and ceiling elements made of X-LAM can be produced in different surface qualities depending on the requirements. We distinguish between non-visual quality (NSI) and visual quality (ISI). The choice of surface quality depends on the later use of the panel and should already be taken into account during planning.

Healthy branches/splay knots

Dead knots

Filled knots

Pitch pockets

Pith

Blue stain discolouration

Joint width

Glue penetration

Traces of planing

Non-visual quality (NSI)

The building material is not visible, as the load-bearing walls and ceilings are subsequently clad on site. In accordance with the specifications of the European approval, the selection of the initial lamellae is made purely from a static point of view from strength class C24 and with a small proportion from strength class C16.

- Joints of up to 6 mm are also permitted between the slats in the transverse layers and up to 3 mm in the longitudinal layers.
- Discolourations such as blue stain and red and brown nail-resistant stripes are permissible.
- Failing branches, even in larger numbers, are not patched up.
- Due to the gluing technology, glue can also partially escape from the surface of the boards.

NSI quality with many marks

NSI quality with few marks

Visual quality (ISI)

The visible quality is recommended when the builder wants to see the wood structure and show the naturalness of the product. This surface quality is most often chosen for the visible areas in office, industrial, residential and commercial buildings.

ISI quality with many marks

ISI quality with few marks

- Specially sorted and finger-jointed lamellas are used for the visible outer layer.
- Healthy, firmly grown knots and wing knots as well as occasional black knots are permissible.
- Outstanding knots ≥ 30 mm are repaired with knothole plugs, “shuttles” etc..
- Fungal and insect infestation are excluded, discolouration due to blue stain is largely absent.
- Resin pockets and visible pith are permissible.
- Based on the production wood moisture content of 10 ± 2%, the maximum joint width between two lamellas is limited to 4 mm as delivered.
- Occasional glue penetrations may occur between the lamellas.
- The visible surface is sanded again after production. As a result, planing marks may still be partially visible.

The exact requirements can be found in the “Cross laminated timber data sheet” of the Studiengemeinschaft Holzleimbau under the item “Industry visual quality”.

Surface quality

Special surfaces

For special optical requirements, various special surfaces can be produced. For example, it is possible to glue on a rod-glued solid wood panel, which fulfils further optical requirements and can be made of different types of wood.

Depending on the type of wood, it can either be used as a load-bearing element and thus replace the outer layer of the panel (e.g. spruce or silver fir), or glued on as an additional layer (e.g. bamboo).

By applying glazes or paints, the wood surface can be designed according to individual wishes.

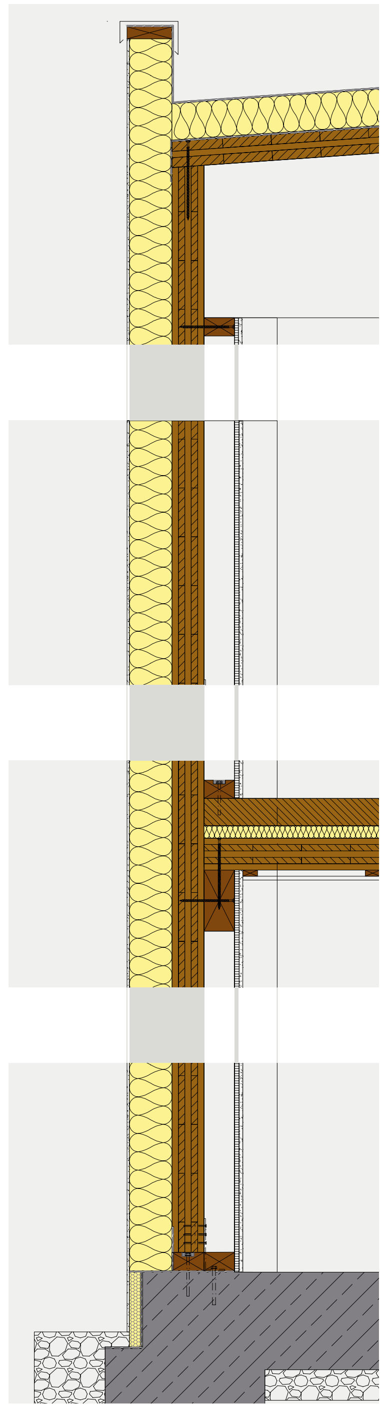
CLT element,
special surface spruce

CLT element,
special surface bamboo

Example structures – Industry and commerce

Benefits of laminated timber construction in industrial buildings:

- The interior surfaces of the walls and ceilings can remain visible. Installations are arranged as wall-mounted installations. Alternatively, low-cost cladding with plasterboard or gypsum fibreboard can be done.
- Building the roof and walls with diaphragm action makes fixed concrete supports unnecessary.
- Economical walls using large-format panel construction
- Easy connections
- Rapid assembly
- Later modifications and extensions are usually possible without great expenditure.



Roof structure
- Two-layer welded sheet
- Resilient insulation 120 mm
- Vapour barrier / wind seal
- X-LAM L-80/3s

U value 0,26 W/m² K

Wall structure
- Mineral plaster
- Insulation mineral fibre 140 mm
- X-LAM X-100/5s
- Service cavity
- Gypsum plasterboard

U value 0,24 W/m² K

Ceiling structure
- Screed
- Impact sound insulation
- X-LAM L-110/5s
- Battens (substructure)
- Gypsum plasterboard

Floor plate wall joint
- Without concrete upstand
- With guide threshold

For unconventional thinkers

Superstructures with maximum flexibility

Ceiling and roof structures

The structure of **L panels** is designed for use in ceiling and roof structures where the main loading is flexure. The outer layers are therefore oriented longitudinally to the panels.

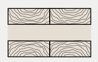
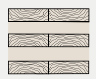
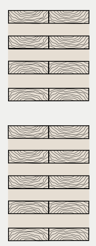
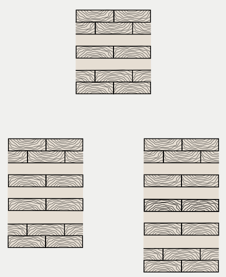
Designation ¹⁾ [-]	**Nominal thickness** [mm]	**Lamellar structure** ²⁾ [mm]	**Dead load** ³⁾ [kN/m²]	**Layers**	**Schema**
L-60/3s	60	|20| $\overline{\underline{20}}$ |20|	0.27	3	
L-80/3s	80	|30| $\overline{\underline{20}}$ |30|	0.36	3	
L-90/3s	90	|30| $\overline{\underline{30}}$ |30|	0.41	3	
L-100/3s	100	|40| $\overline{\underline{20}}$ |40|	0.45	3	
L-110/3s	110	|40| $\overline{\underline{30}}$ |40|	0.50	3	
L-120/3s	120	|40| $\overline{\underline{40}}$ |40|	0.54	3	
L-100/5s	100	|20| $\overline{\underline{20}}$ |20| $\overline{\underline{20}}$ |20|	0.45	5	
L-110/5s	110	|20| $\overline{\underline{20}}$ |30| $\overline{\underline{20}}$ |20|	0.50	5	
L-120/5s	120	|20| $\overline{\underline{30}}$ |20| $\overline{\underline{30}}$ |20|	0.54	5	
L-130/5s	130	|30| $\overline{\underline{20}}$ |30| $\overline{\underline{20}}$ |30|	0.59	5	
L-140/5s	140	|40| $\overline{\underline{20}}$ |20| $\overline{\underline{20}}$ |40|	0.63	5	
L-150/5s	150	|30| $\overline{\underline{30}}$ |30| $\overline{\underline{30}}$ |30|	0.68	5	
L-160/5s	160	|40| $\overline{\underline{20}}$ |40| $\overline{\underline{20}}$ |40|	0.72	5	
L-170/5s	170	|40| $\overline{\underline{30}}$ |30| $\overline{\underline{30}}$ |40|	0.77	5	
L-180/5s	180	|40| $\overline{\underline{30}}$ |40| $\overline{\underline{30}}$ |40|	0.81	5	
L-200/5s	200	|40| $\overline{\underline{40}}$ |40| $\overline{\underline{40}}$ |40|	0.90	5	
L-220/7s	220	|40| $\overline{\underline{20}}$ |40| $\overline{\underline{20}}$ |40| $\overline{\underline{20}}$ |40|	0.99	7	
L-240/7s	240	|40| $\overline{\underline{20}}$ |40| $\overline{\underline{40}}$ |40| $\overline{\underline{20}}$ |40|	1.08	7	
L-260/7s	260	|40| $\overline{\underline{30}}$ |40| $\overline{\underline{40}}$ |40| $\overline{\underline{30}}$ |40|	1.17	7	
L-280/7s	280	|40| $\overline{\underline{40}}$ |40| $\overline{\underline{40}}$ |40| $\overline{\underline{40}}$ |40|	1.26	7	
L-290/9s	290	|40| $\overline{\underline{30}}$ |30| $\overline{\underline{30}}$ |30| $\overline{\underline{30}}$ |30| $\overline{\underline{30}}$ |40|	1.31	9	
L-310/9s	310	|40| $\overline{\underline{30}}$ |40| $\overline{\underline{30}}$ |30| $\overline{\underline{30}}$ |40| $\overline{\underline{30}}$ |40|	1.40	9	
L-320/9s	320	|40| $\overline{\underline{30}}$ |40| $\overline{\underline{30}}$ |40| $\overline{\underline{30}}$ |40| $\overline{\underline{30}}$ |40|	1.44	9	
L-360/9s	360	|40| $\overline{\underline{40}}$ |40| $\overline{\underline{40}}$ |40| $\overline{\underline{40}}$ |40| $\overline{\underline{40}}$ |40|	1.62	9	
LL-190/7s	190	|30| |30| $\overline{\underline{20}}$ |30| $\overline{\underline{20}}$ |30| |30|	0.86	7	
LL-210/7s	210	|30| |30| $\overline{\underline{30}}$ |30| $\overline{\underline{30}}$ |30| |30|	0.95	7	
LL-230/7s	230	|30| |30| $\overline{\underline{40}}$ |30| $\overline{\underline{40}}$ |30| |30|	1.04	7	
LL-240/7s	240	|40| |40| $\overline{\underline{20}}$ |40| $\overline{\underline{20}}$ |40| |40|	1.08	7	
LL-260/7s	260	|40| |40| $\overline{\underline{30}}$ |40| $\overline{\underline{30}}$ |40| |40|	1.17	7	
LL-280/7s	280	|40| |40| $\overline{\underline{40}}$ |40| $\overline{\underline{40}}$ |40| |40|	1.26	7	
LL-300/9s	300	|40| |40| $\overline{\underline{20}}$ |40| $\overline{\underline{20}}$ |40| $\overline{\underline{20}}$ |40| |40|	1.35	9	
LL-330/9s	330	|40| |40| $\overline{\underline{30}}$ |40| $\overline{\underline{30}}$ |40| $\overline{\underline{30}}$ |40| |40|	1.49	9	
LL-360/9s	360	|40| |40| $\overline{\underline{40}}$ |40| $\overline{\underline{40}}$ |40| $\overline{\underline{40}}$ |40| |40|	1.62	9	
LL-400/11s	400	|40| |40| $\overline{\underline{30}}$ |40| $\overline{\underline{30}}$ |40| $\overline{\underline{30}}$ |40| $\overline{\underline{30}}$ |40| |40|	1.80	11	

Table 1

The crosswise structure makes X-LAM components very dimensionally stable and able to take loads along, and transverse to, the main loading direction. In addition to our depicted standard structure designs, we also produce variant structures on request.

Wall structures

The structure of **X panels** is optimised for use in constructing walls that are mainly loaded by vertical forces in the plane of the panel. The outer layers are therefore oriented transverse to the panel longitudinal direction.

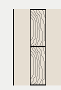
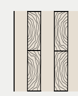
Designation ¹⁾ [mm]	**Nominal thickness** [mm]	**Lamellar structure** ²⁾ [kN/m²]	**Dead load** ³⁾	**Layers**	**Schema**
X-60/3s	60	$\overline{\underline{20}}$ |20| $\overline{\underline{20}}$	0.27	3	
X-70/3s	70	$\overline{\underline{20}}$ |30| $\overline{\underline{20}}$	0.32	3	
X-80/3s	80	$\overline{\underline{30}}$ |20| $\overline{\underline{30}}$	0.36	3	
X-90/3s	90	$\overline{\underline{30}}$ |30| $\overline{\underline{30}}$	0.41	3	
X-100/3s	100	$\overline{\underline{30}}$ |40| $\overline{\underline{30}}$	0.45	3	
X-110/3s	110	$\overline{\underline{40}}$ |30| $\overline{\underline{40}}$	0.50	3	
X-120/3s	120	$\overline{\underline{40}}$ |40| $\overline{\underline{40}}$	0.54	3	
X-100/5s	100	$\overline{\underline{20}}$ |20| $\overline{\underline{20}}$ |20| $\overline{\underline{20}}$	0.45	5	
X-110/5s	110	$\overline{\underline{20}}$ |20| $\overline{\underline{30}}$ |20| $\overline{\underline{20}}$	0.50	5	
X-120/5s	120	$\overline{\underline{20}}$ |30| $\overline{\underline{20}}$ |30| $\overline{\underline{20}}$	0.54	5	
X-130/5s	130	$\overline{\underline{30}}$ |20| $\overline{\underline{30}}$ |20| $\overline{\underline{30}}$	0.59	5	
X-140/5s	140	$\overline{\underline{40}}$ |20| $\overline{\underline{20}}$ |20| $\overline{\underline{40}}$	0.63	5	
X-150/5s	150	$\overline{\underline{30}}$ |30| $\overline{\underline{30}}$ |30| $\overline{\underline{30}}$	0.68	5	
X-160/5s	160	$\overline{\underline{40}}$ |20| $\overline{\underline{40}}$ |20| $\overline{\underline{40}}$	0.72	5	
X-170/5s	170	$\overline{\underline{40}}$ |30| $\overline{\underline{30}}$ |30| $\overline{\underline{40}}$	0.77	5	
X-180/5s	180	$\overline{\underline{40}}$ |30| $\overline{\underline{40}}$ |30| $\overline{\underline{40}}$	0.81	5	
X-190/5s	190	$\overline{\underline{40}}$ |40| $\overline{\underline{30}}$ |40| $\overline{\underline{40}}$	0.86	5	
X-200/5s	200	$\overline{\underline{40}}$ |40| $\overline{\underline{40}}$ |40| $\overline{\underline{40}}$	0.90	5	

Table 2

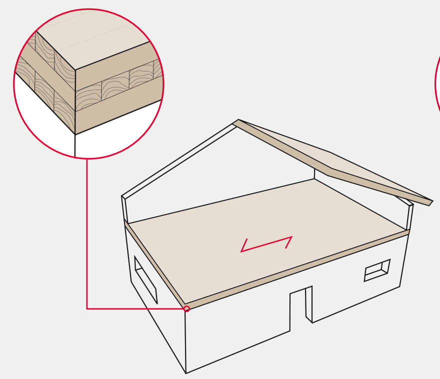


Figure to Table 1

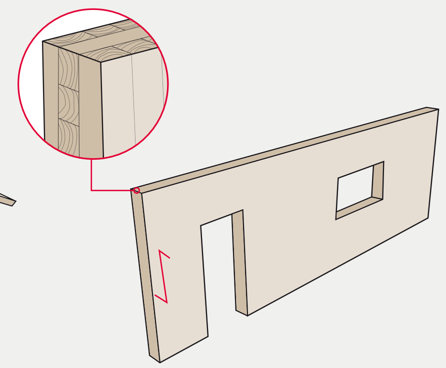


Figure to Table 2

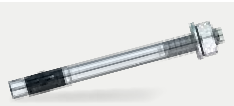
¹⁾ Unless further specified, the design of the outer layers is in non-visible quality.

²⁾ Marking of the lamellar structure:
X= |20| = Orientation of lamellae of the layer in the panel longitudinal direction;
L= $\overline{\underline{20}}$ = Orientation of lamellae of the layer in the panel transverse direction

³⁾ The element weight was determined with a molded density of ρ = 450 kg / m³

Fasteners and lifting aids

Full-thread screw from SPAX®
Picture: © SPAX International GmbH & Co. KG



fischer FAZ II anchor bolt for fixing angle connectors
Picture: © fischerwerke GmbH & Co. KG

Joining X-LAM elements together (general)

In principle all the usual fasteners used in timber construction can be used, such as dowel pins, fit bolts, nails (with sheet metal parts), clamps (for fishplates) and screws. Full-thread screws are preferable, characterised by high load-bearing capacity and fast assembly (no pre-drilling).

Anchoring wall elements to the floor plate

We use various angle connectors fixed in the X-LAM element with annular ring nails (or screws) and in the concrete by heavy-duty anchors.
Suitable anchor bolts are fischer FAZ II; depending on the condition of the concrete, concrete bolts or chemical anchors may also be used.

Laying aids and attachment devices

With a load-bearing capacity of up to 1,000 kg per clamp, the Pitzl PowerClamps make it easy to lift timber beams and glued wooden panels. Only a simple drilled hole is required: the lifting clamp is inserted in a matter of seconds and can easily be taken out after lifting is complete.

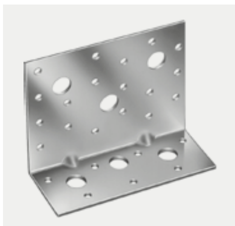
Loop through hole: A lifting loop is looped through a 30 mm hole (Ø ≥ 150 mm) to the edge of the panel. The hole is closed on site.

For transporting X-LAM panels combi-head wood screws can alternatively be screwed into the plane sides (ceiling or roof elements) or narrow sides (wall elements). For load-bearing devices, universal head connectors are used that enclose the bolt head and can be rotated in all directions for attaching to a crane.

Simpson Strong-Tie®
Angle connector ABR90

Simpson Strong-Tie®
Tension anchor HD340M

Simpson Strong-Tie®
Angle connector AKR135L
Angle connector AKR135



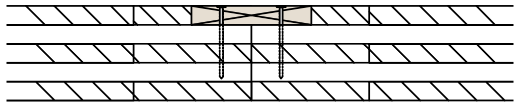
Simpson Strong-Tie®
Angle connector AE116

Simpson Strong-Tie®
Angle connector ABR9015

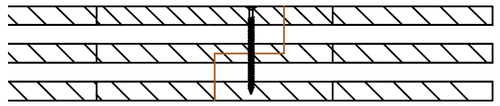
Pictures: SIMPSON STRON-TIE® GmbH

Joining cross-laminated timber elements together (detail solutions)

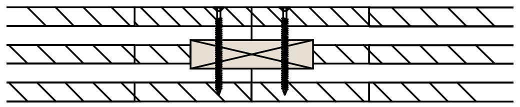
Element joints (wall or ceiling)



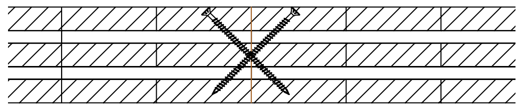
Butt board joined with nails / clamps



Lap joint, joined with full-thread screws



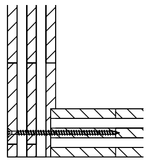
Butt joint, joined using external tongue with full-thread screws



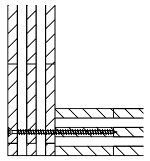
Butt floor joint, joined with full-thread screws at 45°

Because of the limited production dimensions, panel joints are often provided parallel to the stress direction. These are either part of the design or – with diaphragm action – produced according to the structural requirements and implemented with milled-in fishplates or external tongues, rebates or butt joints.

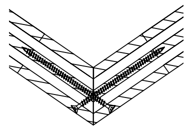
Corner joints CLT walls
Joints with full-thread screws



Inset wall joint

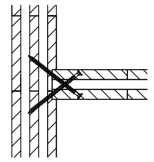


Right-angle butt joint

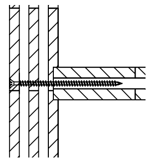


Angled butt joint

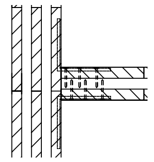
T joints CLT walls



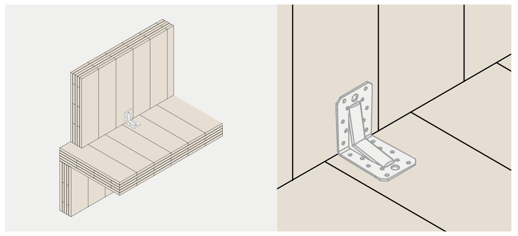
Inset joint, full-thread screws diagonal from inside



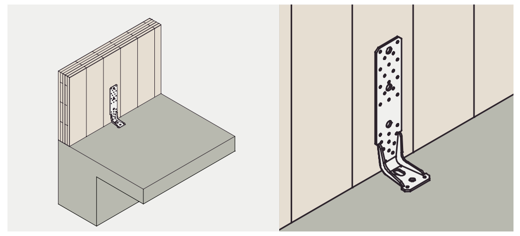
Inset joint, full-thread screws perpendicular from outside



Butt joint, inset angles and annular ring nails / screws



Transmission of tensile, transverse and thrust forces with angle connectors (+ annular ring nails / screws), e.g. Simpson Strong-Tie® ABR90 / 105. These also serve as assembly aid (stop). Joining the wall with the floor beneath is done with full or partial-thread screws.



Transmission of tensile forces by diaphragm action to the wall ends with tension ties, e.g. Simpson Strong-Tie® angle connector AKR. Transmission of thrust forces from horizontal loads (wind) continuous with angles, e.g. ABR90/105/9015 or AE116.

Acoustic protection angle ABAI105 from Simpson Strong-Tie® / Getzner connects construction components without increasing sound transmission. Picture: © Getzner Werkstoffe GmbH

Dimensioning rules
for fasteners

The following summarises the dimensioning rules for fasteners in CLT components in accordance with ETA 11/0189, Appendix 5, to be understood as complementary to EN 1995-1-1.

Information about fasteners in the plane sides is valid only for outer layers made of softwood. Fasteners in the narrow sides of wood panels are not permitted.

Sizing of fasteners in plane sides of CLT

(Surfaces of construction component || to the panel plane)

Loading	⊥ to the pin axis		II to the pin axis	
Fastener	**Shear strength**	**Conditions**	**Pull-out resistance**	**Conditions**
Nails	Hole strength of solid wood taking account of molded density of the layers and the angle between stress and fibre orientation of outer layer	$d \geq 4$ mm $d \geq 6$ mm	$R_{ax,k} = 14 \cdot d^{0,6} \cdot l_{ef}$ [N] profiled nails with d, l_{ef} [mm]	$d \geq 4$ mm $n \geq 2$ each join $l_{ef} \geq 8d$
self-tapping screws (full-thread screws)		$d \geq 6$ mm	$R_{ax,k} = \sum_{i=1}^{n} f_{ax,i,k} \cdot l_{ef} \cdot d$ [N] $f_{ax,i,k}$ = char. pullout parameter of layer i, dep. on $\rho_{k,i}$ and angle α_i betw. screw axis and fibre direction of layer i $l_{ef,i}$ = penetration depth of thread in layer i n = no. of penetrated layers	$d \geq 6$ mm $l_{ef,i} \geq 4d$ Thread engths l_{ef} applicable if: $\alpha \geq 30°$
Dowel pins, fit bolts				
Dowel see ETA Appendix 5 (1.2)				
General	Effective no. of fasteners: n_{ef} = n for outer layers t ≤ 40 mm; otherwise n_{ef} as in EN 1995-1-1 (8.3.1.1)			

Table 3

Sizing of fasteners in narrow sides of CLT

(Surfaces ⊥ to the plane sides of the component)

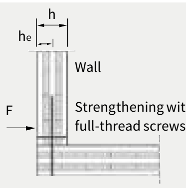
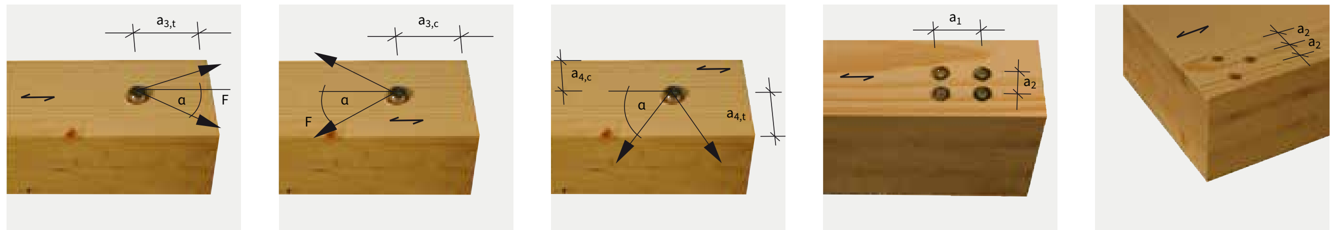
Loading	⊥ to the pin axis		II to the pin axis	
Fastener	**Shear strength**	**Conditions**	**Pull-out resistance**	**Conditions**
self-tapping screws (full-thread screws)	$f_{h,k} = 20 \cdot d^{-0,5}$ [N/mm²]	$d \geq 8$ mm	$R_{ax,k} = \sum_{i=1}^{n} f_{ax,i,k} \cdot l_{ef,i} \cdot d$ [N] see table 1 (fastener in plane sides)	d ≥ 8 mm (others: see table 1 (fastener in plane sides)
General:	Effective no. of fasteners: n_{ef} to EN 1995-1-1 88.3.1.1			
Lateral stress protection against splitting under ⊥ to CLT plane		$h_e/h < 0,7$ → lateral stress protection with full-thread screws rqd. h_e = distance of furthest fastener from loaded edge h = thickness of CLT component		

Table 4

Minimum separation of fasteners in plane sides of cross-laminated timber components

	a_1	$a_{3,t}$	$a_{3,c}$	a_2	$a_{4,t}$	$a_{4,c}$
Nails	(3+3 cos α) d	(7+3 cos α) d	6d	3d	(3+4 sin α) d	3d
Self-tapping screws	4d	6d	6d	2,5d	6d	2,5d
Dowels	(3+2 cos α) 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

Table 5



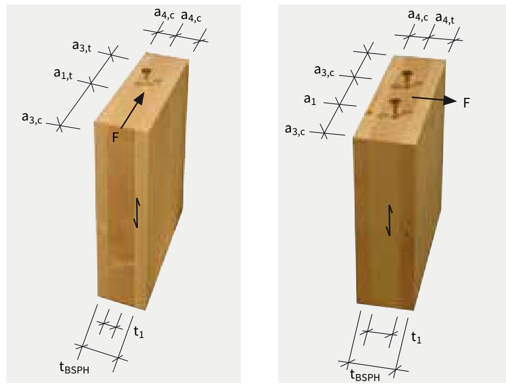
Minimum separation of fasteners in narrow sides of cross-laminated timber components

	a_1	$a_{3,t}$	$a_{3,c}$	a_2	$a_{4,t}$	$a_{4,c}$
Self-tapping screws	10d	12d	7d	3d	6d	3d

	Minimum thickness of layer t_1 in mm	Minimum thickness of cross-laminated timber t_{BSBH} in mm	Minimum penetration depth of connector t_1 or t_2 in mm a)
Self-tapping screws	d ≥ 8mm: 3·d d ≤ 8mm: 2·d	10 · d	10 · d

a) t^1: Minimum penetration depth of connector in lateral components
t^2: Minimum penetration depth of connector in central components

Table 6



Tables 5 & 6 and graphics are from the European Technical Approval for cross-laminated timber (ETA 11/0189, p. 18-21). By kind permission of the German Institute for Building Technology (DIBt, Deutsches Institut für Bautechnik). The full document is available for download from our website (www.derix.de).

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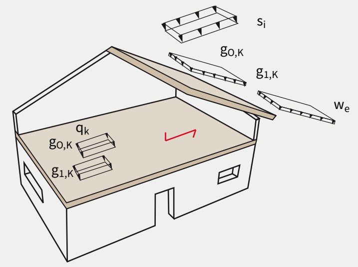
Roof
Draft design



$g_{0,K}$ = constant load from component's own weight
$g_{1,K}$ = constant applied load (ceiling or roof super structure)
q_K = imposed load
s_i = snow load on the roof
w_e = wind pressure on roof surface

Application limits for cross-laminated timber components based on flexure[1] (F)

The tables can help to plan your projects - but they do not replace structural calculations.

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[kN/m²] Constant applied load $g_{1,k}$[2]	SLZ[3]	[kN/m²] Snow load S_k	Span length single-span beam L [m]							
			3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0
0.25	1	0.65			L-80/3s	L-90/3s	L-100/3s	L-110/3s	L-120/3s	
	2	0.85	L-60/3s						L-130/5s	L-160/5s
	3	1.10						L-120/3s		
0.50	1	0.65					L-110/3s			
	2	0.85		L-80/3s	L-90/3s	L-100/3s			L-140/5s	
	3	1.10						L-130/5s		L-170/5s
0.75	1	0.65					L-120/3s			
	2	0.85	L-80/3s					L-140/5s	L-150/5s	L-180/5s
	3	1.10			L-100/3s	L-110/3s			L-160/5s	
1.50	1	0.65		L-90/3s						LL-190/7s
	2	0.85			L-110/3s	L-120/3s	L-140/5s	L-160/5s	L-170/5s	
	3	1.10		L-100/3s						LL-210/7s

Table 7

[kN/m²] Constant applied load $g_{1,k}$[2]	SLZ[3]	[kN/m²] Snow load S_k	Span length double-span beam L [m]							
			3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0
0.25	1	0.65			L-60/3s		L-80/3s	L-90/3s		L-110/3s
	2	0.85							L-100/3s	L-120/3s
	3	1.10					L-90/3s	L-100/3s		L-130/5s
0.50	1	0.65		L-60/3s		L-80/3s	L-80/3s	L-90/3s		L-120/3s
	2	0.85								L-130/5s
	3	1.10	L-60/3s		L-80/3s		L-90/3s	L-100/3s	L-110/3s	L-140/5s
0.75	1	0.65								L-130/5s
	2	0.85								L-140/5s
	3	1.10							L-120/3s	
1.50	1	0.65		L-80/3s		L-90/3s	L-100/3s	L-110/3s		L-150/5s
	2	0.85							L-130/5s	L-160/5s
	3	1.10	L-80/3s		L-90/3s	L-100/3s	L-110/3s	L-120/3s		

Table 8

[kN/m²] Const. papplied load$g_{1,k}$[2]	SLZ[3])	[kN/m²] Snow load S_k	Span length triple-span beam L[m]							
			3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0
0.25	1	0.65		L-60/3s			L-80/3s	L-90/3s	L-100/3s	L-120/3s
	2	0.85								L-130/5s
	3	1.10		L-80/3s		L-80/3s	L-90/3s	L-100/3s	L-110/3s	L-140/5s
0.50	1	0.65		L-60/3s						L-130/5s
	2	0.85	L-60/3s		L-80/3s					
	3	1.10						L-110/3s		L-140/5s
0.75	1	0.65				L-90/3s	L-100/3s	L-100/3s	L-120/3s	
	2	0.85		L-80/3s				L-110/3s		
	3	1.10								
1.50	1	0.65						L-120/3s		L-160/5s
	2	0.85	L-80/3s		L-90/3s	L-100/3s	L-110/3s		L-140/5s	
	3	1.10						L-130/5s		

Table 9

[1] Deformation factor as BS EN 1995-1-1 for service class 1: k_{def} = 0,8 limit values of deformation as in BS EN 1995-1-1/NA; w_{inst} = L/300; w_{fin} = L/150; $w_{net,fin}$ = L/25

[2] Additional load $g_{1,k}$; the elements' own weight is already allowed for in the results with ρ = 450 kg/m³

3) The table uses the stated basic amounts for S_k . For higher values separate calculations are required.

Identification of elements for fire resistance as in EN 1995-1-2 (1-sided burning, below; $ß_0$ = 0.65 mm/min

- L-60/Js | RO (FO)
- L-100/3s | R3O (F3O)
- L-130/5s | R9O (F9O)

Ceiling (single span beam)
Draft design

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Application limits for cross-laminated timber components based on flexure [1] (F)

The tables can help to plan your projects - but they do not replace structural calculations.

[kN/m²] Constant applied load $g_{1,k}$[2]	[kN/m²] Live load q_k[3]	Span length single-span beam L [m]							
		3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0
0.5	1.5	L-80/3s	L-90/3s	L-100/3s	L-110/3s	L-130/5s	L-140/5s	L-160/5s	LL-190/7s
	2.0				L-120/3s	L-140/5s	L-150/5s		
	3.0	L-90/3s	L-100/3s	L-110/3s	L-130/5s	L-150/5s	L-160/5s	L-180/5s	LL-210/7s
	4.0		L-110/3s	L-120/3s	L-140/5s	L-160/5s	L-180/5s	LL-190/7s	LL-230/7s
	5.0	L-100/3s		L-140/5s	L-160/5s	L-170/5s	LL-190/7s	LL-210/7s	LL-240/7s
1.0	1.5	L-80/3s	L-90/3s	L-110/3s	L-120/3s	L-140/5s	L-160/5s	L-170/5s	LL-190/7s
	2.0		L-100/3s		L-130/5s			L-180/5s	LL-210/7s
	3.0	L-90/3s		L-120/3s	L-140/5s	L-160/5s	L-170/5s	LL-190/7s	LL-230/7s
	4.0	L-100/3s	L-110/3s	L-130/5s	L-150/5s		LL-190/7s		LL-240/7s
	5.0		L-120/3s	L-140/5s	L-160/5s	L-180/5s		LL-210/7s	
1.5	1.5	L-90/3s	L-100/3s	L-110/3s	L-130/5s	L-150/5s	L-160/5s	L-180/5s	LL-210/7s
	2.0			L-120/3s	L-140/5s	L-160/5s	L-170/5s	LL-190/7s	LL-230/7s
	3.0		L-110/3s	L-130/5s			L-180/5s		
	4.0	L-100/3s	L-120ßs	L-140/5s	L-160/5s	L-170/5s	LL-190/7s	LL-210/7s	LL-240/7s
	5.0					L-180/5s			LL-260/7s
2.0	1.5	L-90/3s	L-100/3s	L-120/3s	L-140/5s	L-160/5s	L-170/5s	LL-190/7s	L-220/7s
	2.0		L-110/3s	L-130/5s			L-180/5s		LL-230/7s
	3.0	L-100/3s	L-120/3s	L-140/5s	L-160/5s	L-170/5s	LL-190/7s	LL-210/7s	LL-240/7s
	4.0					L-180/5s			
	5.0	L-110/3s	L-130/5s	L-150/5s	L-170/5s	L-190/7s	LL-210/7s	LL-230/7s	LL-260/7s

Table 10

[1] Deformation factor as in BS EN 1995-1-1 for service class 1: k_{def} = 0,8; limit values of deformation as in BS EN 1995-1-1/NA: W_{inst} = L/300; W_{fin} = L/1 50; $W_{net,fin}$ = L/250

[2] Additional load $g_{1,k}$ excluding component weight $g_{0,k}$ (this is already allowed for in the results with p = 450 kg/m³)

[3] Live load categories as in BS EN 1991-1-1/NA 1DE: A (living areas) or B (office areas)

[4] Basis for calculation, general: damping 2.5%, disturbing vibrations in the adjacent span, no account of stiffness of screed Hamm/ Richter: assessment 1.5 - 2.5 ; ceilings in one use unit, e.g. ceilings in single-family houses, existing ceilings or by agreement with the client; natural frequency f ≥ 6 Hz; Stiffness w(2kN) ≤ 1.0 mm with b_{eff} = 1 m; design requirements (bare floor, fill, screed) to be allowed for. BS EN 1995-1-1/NA: natural frequency f ≥ 8 Hz; stiffness w(1 kN) 2.0 mm (all sections meet the normal requirements); vibration velocity v

Application limits for cross-laminated timber components based on vibration [4] (S)

[kN/m²] Constant applied load $g_{1,k}$[2]	[kN/m²] Live load q_k[3]	Span length single-span beam L [m]															
		3.0		3.5		4.0		4.5		5.0		5.5		6.0		7.0	
		S (≥6Hz)	S (≥8Hz)	S (≥6Hz)	S (≥8Hz)	S (≥6Hz)	S (≥8Hz)	S (≥6Hz)	S (≥8Hz)	S (≥6Hz)	S (≥8Hz)	S (≥6Hz)	S (≥8Hz)	S (≥6Hz)	S (≥8Hz)	S (≥6Hz)	S (≥8Hz)
0.5	1.5		L-80/3s		L-90/3s		L-100/3s		L-110/3s		L-140/5s						
	2.0								L-120/3s				L-160/5s		L-190/7s		
	3.0		L-90/3s		L-100/3s		L-110/3s		L-130/5s		L-150/5s						LL-240/7s
	4.0				L-110/3s		L-120/3s		L-140/5s		L-160/5s		L-180/5s				
	5.0		L-100/3s				L-140/5s		L-160/5s		L-170/5s		LL-190/7s				
1.0	1.5		L-80/3s		L-90/3s		L-110/3s		L-130/5s								
	2.0				L-100/3s						L-160/5s		L-180/5s		LL-210/7s		
	3.0		L-90/3s				L-120/5s		L-140/5s								LL-260/7s
	4.0		L-100/3s		L-110/3s		L-130/5s		L-150/5s								
	5.0	L-110/3s		L-130/5s	L-120/3s	L-150/5s	L-140/5s	L-170/5s	L-160/5s	LL-190/7s		LL-210/7s		L-220/7s		L-260/7s	
1.5	1.5		L-90/3s		L-100/3s		L-120/3s										
	2.0								L-150/5s		L-180/5s		LL-190/7s				
	3.0				L-110/3s		L-130/5s								LL-230/7s		
	4.0		L-100/3s		L-120/3s												
	5.0																L-300/9s
2.0	1.5		L-90/3s		L-110/3s		L-140/5s		L-160/5s								
	2.0																
	3.0		L-100/3s		L-120/3s						LL-190/7s		LL-210/7s		LL-240/7s		
	4.0																
	5.0		L-110/3s		L-130/5s		L-150/5s		L-170/5s					LL-230/7s			

Table 11

Ceiling (double span beam)
Draft design

The tables can help to plan your projects – but they do not replace structural calculations.

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Application limits for cross-laminated timber components based on flexure [1] (F)

[kN/m²] Constant applied load $g_{1,k}$ [2]	[kN/m²] Live load q_k [3]	Span length double-span beam L [m] 3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0
0,5	1.5	L-60/3s	L-80/3s	L-80/3s	L-90/3s	L-100/3s	L-110/3s	L-120/3s	L-150/5s
	2.0	L-80/3s		L-90/3s	L-100/3s	L-110/3s	L-120/3s	L-140/5s	L-160/5s
	3.0		L-90/3s	L-100/3s	L-110/3s	L-120/3s	L-140/5s	L-160/5s	L-180/5s
	4.0				L-120/3s	L-140/5s	L-160/5s		LL-190/7s
	5.0	L-90/3s	L-100/3s	L-110/3s	L-130/5s			L-180/5s	LL-210/7s
1,0	1.5	L-80/3s	L-80/3s	L-90/3s	L-100/3s	L-110/3s	L-120/3s	L-130/5s	L-160/5s
	2.0					L-120/3s	L-130/5s	L-140/5s	L-170/5s
	3.0		L-90/3s	L-100/3s	L-110/3s	L-130/5s	L-140/5s	L-160/5s	LL-190/7s
	4.0		L-100/3s	L-110/3s	L-120/3s	L-140/5s	L-160/5s	L-170/5s	
	5.0	L-90/3s		L-120/3s	L-140/5s	L-150/5s		L-180/5s	LL-210/7s
1.5	1.5	L-80/3s	L-80/3s	L-90/3s	L-100/3s	L-130/5s	L-130/5s	L-140/5s	L-170/5s
	2.0			L-100/3s	L-110/3s		L-140/5s	L-160/5s	L-180/5s
	3.0		L-90/3s		L-120/3s	L-140/5s	L-150/5s		LL-190/7s
	4.0		L-100/3s	L-100/3s	L-130/5s		L-160/5s	L-180/5s	LL-210/7s
	5.0	L-90/3s		L-120/3s	L-140/5s	L-160/5s	L-170/5s	LL-190/7s	LL-230/7s
2.0	1.5	L-80/3s	L-80/3s	L-100/3s	L-110/3s	L-130/5s	L-140/5s	L-150/5s	L-180/5s
	2.0		L-90/3s		L-110/3s			L-160/5s	
	3.0		L-100/3s	L-110/3s	L-120/3s	L-140/5s	L-160/5s	L-170/5s	LL-190/7s
	4.0	L-90/3s		L-120/3s	L-130/5s	L-150/5s		L-180/5s	LL-210/7s
	5.0		L-110/3s		L-140/5s	L-160/5s	L-170/5s	LL-190/7s	L-220/7s

Table 12

1) Deformation factor as in BS EN 1995-1-1 for service class 1: k_{def} = 0,8; limit values of deformation as in BS EN 1995-1-1/NA: W_{inst} = L/300; W_{fin} = L/1 50; $W_{net,fin}$ = L/250

2) Additional load $g_{1,k}$ excluding component weight $g_{0,k}$ (this is already allowed for in the results with p = 450 kg/m³)

3) Live load categories as in BS EN 1991-1-1/NA 1DE: A (living areas) or B (office areas)

4) Basis for calculation, general: damping 2.5%, disturbing vibrations in the adjacent span, no account of stiffness of screed Hamm/Richter: assessment 1.5 - 2.5 ; ceilings in one use unit, e.g. ceilings in single-family houses, existing ceilings or by agreement with the client; natural frequency f ≥ 6 Hz; Stiffness w(2kN) ≤ 1.0 mm with b_{eff} = 1 m; design requirements (bare floor, fill, screed) to be allowed for. BS EN 1995-1-1/NA: natural frequency f ≥ 8 Hz; stiffness w(1 kN) 2.0 mm (all sections meet the normal requirements); vibration velocity v

Identification of elements for fire resistance as in EN 1995-1-2 (1-sided burning, below; $ß_0$ = 0,65 mm/min)

- L-60/3s | RO (FO)
- L-100/3s | R3O (F3O)
- L-130/5s | R9O (F9O)

Application limits for cross-laminated timber components based on vibration [4] (S)

[kN/m²] Constant applied load $g_{1,k}$ [2]	[kN/m²] Live load q_k [3]	3.0 S (≥6Hz)	3.0 S (≥8Hz)	3.5 S (≥6Hz)	3.5 S (≥8Hz)	4.0 S (≥6Hz)	4.0 S (≥8Hz)	4.5 S (≥6Hz)	4.5 S (≥8Hz)	5.0 S (≥6Hz)	5.0 S (≥8Hz)	5.5 S (≥6Hz)	5.5 S (≥8Hz)	6.0 S (≥6Hz)	6.0 S (≥8Hz)	7.0 S (≥6Hz)	7.0 S (≥8Hz)
0.5	1.5	L-100/3s	L-60/3s	L-120/3s	L-80/3s	L-140/5s	L-90/3s	L-160/5s	L-110/3s	L-170/5s	L-140/5s	LL-190/7s	L-160/5s	L-220/7s	L-190/7s	L-240/7s	LL-240/7s
	2.0		L-80/3s														
	3.0				L-90/3s		L-100/3s										
	4.0								L-120/3s								
	5.0		L-90/3s		L-100/3s		L-110/3s		L-130/5s								
1.0	1.5		L-80/3s		L-90/3s						L-160/5s		L-180/5s		LL-210/7s		LL-260/7s
	2.0																
	3.0																
	4.0				L-100/3s												
	5.0		L-90/3s				L-120/3s		L-140/5s								
1.5	1.5		L-80/3s						L-150/5s		L-180/5s		LL-190/7s		LL-230/7s		L-300/9s
	2.0																
	3.0																
	4.0																
	5.0		L-90/3s														
2.0	1.5		L-90/3s		L-110/3s		L-140/5s		L-160/5s		LL-190/7s		LL-210/7s		LL-240/7s		
	2.0																
	3.0																
	4.0																
	5.0																

Table 13

Application example for draft-design tables
Ceiling structure:

Tiles (8 mm):	0.22 kN/m²/cm x 0,8 cm	=	0. 18 kN/m²
Cement screed (6 cm):	0.22 kN/m²/cm x 6.0 cm	=	1.32 kN/m²
Impact sound insulation (EPS) (6 cm):	0.35 kN/m³ x 0,06 m	=	0.02 kN/m²
Gypsum fibreboard 2x (impact sound):	0.09 kN/m²/cm x 2 x 1,25 cm	=	0.23 kN/m²
X-LAM ceiling component: The own-weight is already allowed for in the results.			
Battens (24/48, e = 50 cm)	6.00 kN/m³ x 0,024 m x 0,048 m /0,50 m	=	0.01 kN/m²
Gypsum plasterboard (2x):	0,09 kN/m²/cm x 2 x 1,25 cm	=	0.23 kN/m²
	Σ constant applied load $g_{1,k}$	=	1.99 kN/m²
Live load category B1 (office area)	Traffic load q_k	=	2.00 kN/m²
	Added for partition wall Δ q_k	=	0,80 kN/m²
	Σ variable load q_k	=	2,80 kN/m²
Input values for the reading: $g_{1,k}$ = 2.00 kN/m²; q_k = 3.00 kN/m²; Span length L = 4.50 m (double-span beam)			required cross-laminated timber L-120/3s deflection analysis; L-160/5s vibration analysis

Ceiling (triple span beam)
Draft design

The tables can help to plan your projects – but they do not replace structural calculations.

www.x-lam.de/dimensioning

Application limits for cross-laminated timber components based on flexure [1] (F)

[kN/m²] Constant applied load $g_{1,k}$ [2]	[kN/m²] Live load q_k [3]	Span length triple-span beam L [m] 3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0
0,5	1.5	L- 80/3s	L-80/3s	L-90/3s	L-100/3s	L-110/3s	L-120/3s	L-130/5s	L-160/5s
	2.0						L-130/5s	L-140/5s	L-170/5s
	3.0		L-90/3s	L-100/3s	L-110/3s	L-130/5s	L-140/5s	L-160/5s	LL-190/7s
	4.0		L-100/3s	L-110/3s	L-120/3s	L-140/5s	L-160/5s	L-170/5s	
	5.0	L-90/3s		L-120/3s	L-140/5s	L-160/5s		L-180/5s	LL-210/7s
1,0	1.5	L-80/3s	L-80/3s	L-90/3s	L-100/3s	L-110/3s	L-130/5s	L-140/5s	L-170/5s
	2.0			L-100/3s	L-110/3s	L-120/3s	L-140/5s	L-160/5s	L-180/5s
	3.0		L-90/3s		L-120/3s	L-140/5s	L-160/5s		LL-190/7s
	4.0	L-90/3s	L-100/3s	L-110/3s	L-130/5s			L-180/5s	LL-210/7s
	5.0			L-120/3s	L-140/5s	L-160/5s	L-170/5s	LL-190/7s	
1.5	1.5	L-80/3s	L-80/3s	L-100/3s	L-110/3s	L-120/3s	L-140/5s	L-160/5s	L-180/5s
	2.0		L-90/3s			L-130/5s			LL-190/7s
	3.0		L-100/3s	L-110/3s	L-120/3s	L-140/5s	L-160/5s	L-170/5s	
	4.0	L-90/3s		L-120/3s	L-140/5s	L-160/5s		L-180/5s	LL-230/7s
	5.0		L-110/3s	L-130/5s			L-180/5s	LL-190/7s	
2.0	1.5	L-80/3s	L-90/3s	L-100/3s	L-110/3s	L-130/5s	L-140/5s	L-160/5s	LL-190/7s
	2.0				L-120/3s	L-140/5s	L-160/5s		
	3.0	L-90/3s	L-100/3s	L-110/3s	L-130/5s			L-180/5s	LL-210/7s
	4.0			L-120/3s	L-140/5s	L-160/5s	L-170/5s	LL-190/7s	
	5.0	L-100/3s		L-130/5s			L-180/5s		LL-240/7s

Table 14

[1] Deformation factor as in BS EN 1995-1-1 for service class 1: k_{def} = 0,8; limit values of deformation as in BS EN 1995-1-1/NA: W_{inst} = L/300; W_{fin} = L/1 50; $W_{net,fin}$ = L/250

[2] Additional load $g_{1,k}$ excluding component weight $g_{0,k}$ (this is already allowed for in the results with p = 450 kg/m³)

[3] Live load categories as in BS EN 1991-1-1/NA 1DE: A (living areas) or B (office areas)

[4] Basis for calculation, general: damping 2.5%, disturbing vibrations in the adjacent span, no account of stiffness of screed Hamm/Richter: assessment 1.5 - 2.5 ; ceilings in one use unit, e.g. ceilings in single-family houses, existing ceilings or by agreement with the client; natural frequency f ≥ 6 Hz; Stiffness w(2kN) ≤ 1.0 mm with b_{eff} = 1 m; design requirements (bare floor, fill, screed) to be allowed for. BS EN 1995-1-1/NA: natural frequency f ≥ 8 Hz; stiffness w(1 kN) 2.0 mm (all sections meet the normal requirements); vibration velocity v

Identification of elements for fire resistance as in EN 1995-1-2 (Abbrand 1-sided burning, below; $ß_0$ = 0,65 mm/min)

- L-60/3s | RO (FO)
- L-100/3s | R3O (F3O)
- L-130/5s | R9O (F9O)

Application limits for cross-laminated timber components based on vibration [4] (S)

[kN/m²] Constant applied load $g_{1,k}$ [2]	[kN/m²] Live load q_k [3]	Span length triple-span beam L [m] 3.0 S (≥6Hz)	3.0 S (≥8Hz)	3.5 S (≥6Hz)	3.5 S (≥8Hz)	4.0 S (≥6Hz)	4.0 S (≥8Hz)	4.5 S (≥6Hz)	4.5 S (≥8Hz)	5.0 S (≥6Hz)	5.0 S (≥8Hz)	5.5 S (≥6Hz)	5.5 S (≥8Hz)	6.0 S (≥6Hz)	6.0 S (≥8Hz)	7.0 S (≥6Hz)	7.0 S (≥8Hz)
0.5	1.5	L-100/3s	L-80/3s	L-110/3s	L-80/3s	L-140/5s	L-90/3s	L-160/5s	L-110/3s	L-170/5s	L-140/5s	LL-190/7s	L-160/5s	LL-190/7s	L-190/7s	LL-230/7s	LL-240/7s
	2.0																
	3.0				L-90/3s		L-100/3s										
	4.0				L-100/3s		L-110/3s		L-120/3s								
	5.0		L-90/3s				L-120/3s		L-140/5s		L-160/5s						
1.0	1.5		L-80/3s		L-90/3s		L-110/3s		L-130/5s		L-160/5s		L-180/5s		LL-210/7s		LL-260/7s
	2.0																
	3.0																
	4.0		L-90/3s		L-100/3s												
	5.0						L-120/3s		L-140/5s								
1.5	1.5		L-80/3s						L-150/5s		L-180/5s		LL-190/7s		LL-230/7s		LL-300/9s
	2.0																
	3.0																
	4.0		L-90/3s														
	5.0						L-130/5s										
2.0	1.5				L-110/3s		L-140/5s		L-160/5s		LL-190/7s		LL-210/7s		LL-240/7s	LL-240/7s	LL-300/9s
	2.0																
	3.0																
	4.0																
	5.0		L-100/3s														

Table 15

Wall
Draft design

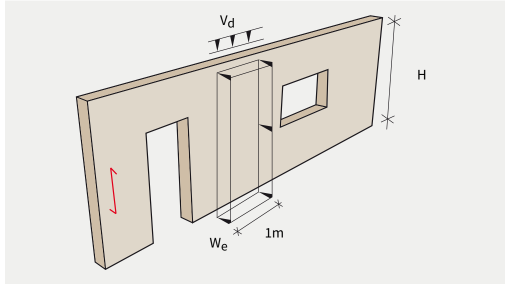
The tables can help to plan your projects – but they do not replace structural calculations.

Draft-design table for wall components

Application limits for cross-laminated timber components based on load-bearing capacity (interaction M+N)

Fire protection[1]	Application[2]	Hight H [m]	Vertical load vd [3] at wall head [kN/m] 40	60	80
RO (FO)	Exterior wall	1.5 2.8 3.5 4.5	X-60/3s	X-60/3s	X-60/3s
					X-70/3s
				X-70/3s	X-80/3s
R30 (F30) 1-sided	Interior/ exterior wall	1.5 2.8 3.5 4.5	X-100/5s		

Table 16



V_d= design value of vertical load [kN/m]
W_e= wind pressure on exterior wall in [kN/m²]

[1] Fire rating to BS EN 1995-1-2: $k_{mod,fi}$ = 1.0 and $Y_{M,fi}$ = 1,0

[2] For wall designs up to wind load zone 2 inland, wind loadings are not decisive. Exterior pressure coefficient c_{pe} = 0,8 (range D); resulting pressure w_e = 0,8*q

[3] The normal force component from the element's own weight with ρ = 450 kg/m³ already included in the results. For the fire rating the corresponding design value $_{vd,fi}$ should be used. Basis for calculation: Equivalent member method with buckling length = height H; 1 m wide wall strip; NKL 1; System coefficient k_l = 1,0; Design location in wall centre (H/2)

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