Massivholz GmbH

# Construction

KLHonline

www.KLH.at

the.next.generation.in.timber.construction

Timber construction has a tradition going back thousands of years. It is particularly relevant at the present time. Due to rapid technical development of material components, processing methods and joining procedures, timber construction is today more powerful than ever.

This leaflet contains information regarding
- The range of KLH solid timber boards which can be used as construction elements
- The ecological advantages of timber as a natural raw material
- The variety of available forms and constructions
- The various areas of application
- Technical details.

# KLH – the. next. generation. in. timber. construction

Trees Forests Timber

## $CO_2$ neutral

Timber is $CO_2$ neutral, when it is used in buildings, carbon dioxide is permanently bonded. Even if it rots or is burnt, no more carbon dioxide is emitted than has already been absorbed by way of photosynthesis. In this way, any additional burden on the environment can be avoided.

Living with timber is living in harmony with nature.

# Design and architecture using cross-laminated timber

Timber construction has always presented an opportunity for architects and designers wanting to create timeless design.

Timber offers distinct advantages compared to traditional solid constructions:

- Favourable dead weight in relation to its strength
- Alterations are possible
- Components can be replaced
- No problems with reinforcing.

KLH solid timber boards can be combined with steel, aluminium, glass and all other commonly used materials in any way.

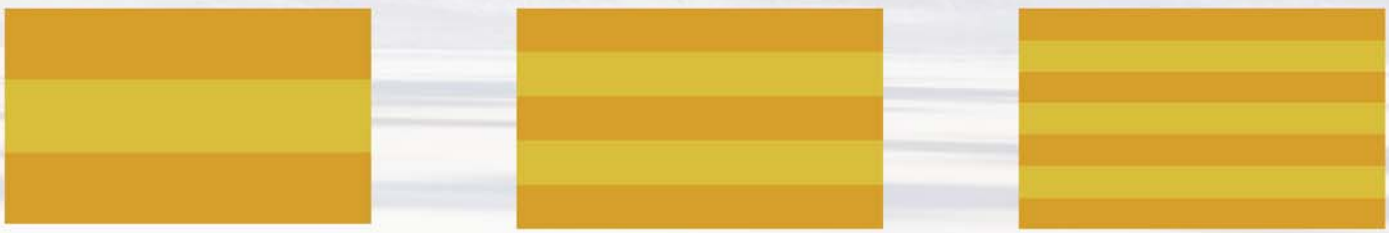
The variety of combinations offered by timber construction have certainly not been exhausted either from a constructional or an architectural point of view.

Thanks to technological progress, a gracefully designed, transparent architecture is now possible on the basis of solid timber construction.

# Product description of cross-laminated timber

The product of KLH Massivholz GmbH is continuously being refined. International research and testing authorities are integrated in this comprehensive process.

Cross-laminated timber consists of timber strips stacked upon each other layer by layer, glued together over the entire surface, using 3, 5, 7 or more layers depending on the requirements and the thickness of the board.



The arrangement of the lengthwise and crosswise strips helps to reduce the degree of swelling and shrinkage at the level of the board to a minimum, and static strength and dimensional stability are increased considerably.
In comparison to other commonly used timber construction materials, they offer completely new possibilities of load transfer. Loads may not only be transferred in one direction (as is the case with columns, beams, etc.), but to all sides - this is described as a genuine plate and sheet action.

The base material used for KLH solid timber boards is Austrian softwood - preferably the so-called “side wood” from the edge zones of the trunk of fast-growing spruce trees.
The thickness of the strips ranges from 10 to 40 mm, depending on the format of a board and the constructional requirements.
Depending on the equilibrium moisture to be expected, boards with a moisture content of 12% (+/- 2) are glued together.

All strips have to undergo strict visual and mechanical quality sorting measures. Strips with weak points, for example knots, spiral growth or other growth anomalies are discarded.
Strips with an excessively high or low timber moisture level that might result in destructive fungal and/or insect attacks of the timber are also discarded.

# Production of cross-laminated timber

Exact planning and preparation are prerequisites for cost effective and optimised production.

Standard KLH solid timber boards are manufactured to a non-visual (both sides) or an industrial (one side visual, one side non-visual) quality. Therefore they are to be regarded as industrially manufactured shell elements.

The manufacturing of visual quality boards (both sides visible) for exposed interior applications is relatively expensive on account of the board formats required for this, but these are available upon request. The utmost care must be taken when handling these elements. Prevention of damage caused through transport, storage and assembly can not be quaranteed.

In addition to the multi-purpose KLH solid timber boards, various types of surfaces (OSB, hardboard, etc.) are available upon request.

# Gluing of cross-laminated timber

Individual strip layers are glued using, the PUR adhesive Purbond HB 110 produced by Collano. It has been tested according to DIN 68141 and other criteria by FMPA Baden-Württemberg, Otto Graf Institut, Stuttgart.
Purbond HB 110 has been approved for the production of load-bearing timber construction parts and special methods of construction for both indoor and outdoor applications according to DIN 1052 and EN 301.
The glue is applied in an automated manner, covering all surfaces.
The quantity of adhesive used is 0.2 kg/m$^2$ on board surfaces, with additional glue used at the joints.
Collano Purbond HB110 is a solvent-free and formaldehyde-free single-component adhesive that hardens into a viscous, elastic film under the influence of material and atmospheric moisture within a few hours.
In this way, a three-dimensional, hydrolysis resistant network consisting of completely stable polyurethane and polyurea compounds is created.

Unlike phenol-formaldehyde resins, hardened PUR systems such as Collano HB 110 cannot release formaldehyde, on account of their chemical structure.
This has been confirmed by an analytical study which was carried out by EMPA (The Swiss Federal Laboratories for Materials Testing and Research) in Zurich.

As no foaming is necessary when timber is glued together, this adhesive is also completely free from CFC´s because no expanding agents are used.

Timber that has been glued using PUR adhesive can be disposed of in a supervised incinerator plant without giving any cause for concern. When it is burnt completely, there is no difference to timber that has not been glued together.

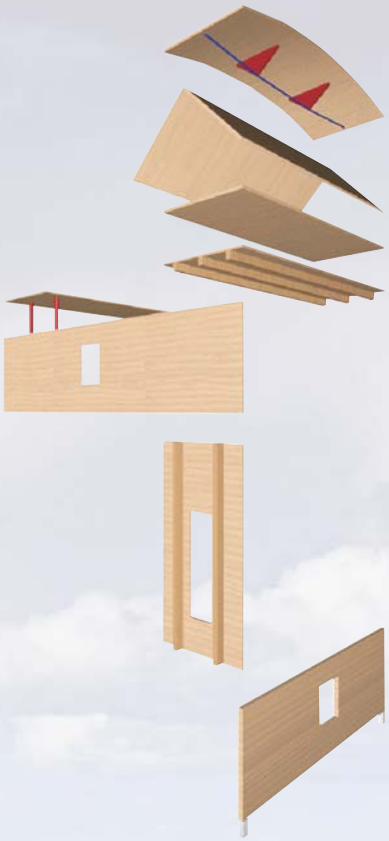
# Construction using cross-laminated timber

The pre-fabrication of the largest possible construction units using modern factory methods of production is a special matter of interest in today´s construction industry.

With a maximum length of 16.5 m, a maximum thickness of 0.5 m and a maximum width of 2.95 m, KLH solid timber boards exactly fulfil the requirements of the market.
The favourable “power/weight ratio” facilitates transporting and enables an easy and fast placement of the elements by crane (to be provided by the customer).

Even multi-storey buildings can be erected within a few days - a rain-tight, dry shell ready for cladding and fit-out is constructed within the shortest possible time.

# Areas of application of cross-laminated timber



## KLH for roofs

## KLH for ceilings

## KLH for walls

- Housing construction
- Construction of office / commercial buildings
- Construction of industrial halls
- Fair and exhibition halls
- Educational institutions
- Sports and recreational facilities
- Sacred architecture
- Bridge construction
- .....

MINIMAL JOINTING: A major advantage of KLH solid timber boards is the large surface area of the elements that helps to minimise the number of joints in the completed building.

DIMENSIONAL STABILITY: Thanks to the crosslaminated structure of the boards, swelling and shrinkage at the level of the boards is negligible. Settlement effects are also a thing of the past.

OPENINGS: Doors and windows, slots, or holes in the ceiling can be realised using common timber processing machines. Windows and doors can be realised without any additional construction measures in many cases - the ceiling plate above is often sufficient for bridging openings.

RENOVATION: Timber is particularly suitable for converting or enlarging existing buildings - whether for architectural reasons or in order to create additional living space - because it is a light building material.

SIMPLE CONNECTIONS: On account of the size of the individual elements, the forces required for anchoring in the foundation as well as between several individual elements are relatively small. Simple screwed connections are sufficient in many cases.

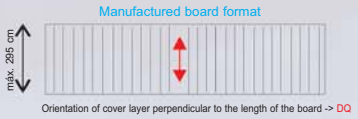
OPTIMISATION: The size and the thickness of KLH solid timber boards have been optimised on the basis of past experience (the appropriate selection of wall and ceilings thickness depends on the relevant static requirements).

STANDARDISATION: The use of standard formats results in additional cost advantages for architects, planners and building owners.

IMAGINATION: Unconventional construction offers scope for trying new things - KLH solid timber boards offer almost unlimited design opportunities.

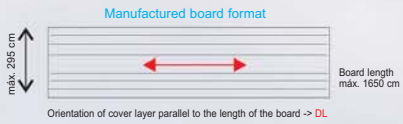
# Standard components

| KLH board thickness in mm | Layers |
|---|---|
| 63 | 3 |
| 78 (standard) | 3 |
| 94 (standard) | 3 |
| 102 | 3 |
| 95 (standard) | 5 |
| 128 (standard) | 5 |
| 158 | 5 |




Used predominantly for walls

| KLH board thickness in mm | Layers |
|---|---|
| 60 (standard) | 3 |
| 78 | 3 |
| 90 (standard) | 3 |
| 98 | 3 |
| 102 | 3 |
| 108 (standard) | 3 |
| 101 | 5 |
| 117 | 5 |
| 125 | 5 |
| 128 (standard) | 5 |
| 146 (standard) | 5 |
| 162 (standard) | 5 |
| 170 | 5 |
| 182 | 5 |
| 202 (standard) | 7 |
| 226 (standard) | 7 |
| 256 | 7 |
| 230 | 7 |




Used predominantly for ceilings

The cutting accuracy is within the tolerances for building construction according to DIN (Deutsches Institut für Normung - German standards institute) 18203/Part 3 for wall, floor, ceiling and roof boards made of timber materials.

# Technical approvals

Austrian technical approval
ÖTZ - 1998/137/6

Austrian technical approval for KLH solid timber boards has been in place since December 1998. This approval confirms that the construction product is suitable for use according to the generally approved rules of technology.
The statistical parameters for the calculation of load-bearing structures made of cross-laminated timber are also stated in the approval.

Germany: general approval
Z – 9.1 – 482
issued by the construction supervising authority, valid until 31 May 2005

In May 2000, a general approval was issued by the construction supervising authority for Germany.
The Deutsche Institut für Bautechnik (DIBt) has granted this approval on the basis of an expert paper prepared by Univ.-Prof. Dr. Ing. H. J. Blaß.

KLH Massivholz GmbH also holds approval for gluing operations which is granted in Germany by the Forschungs- und Materialprüfanstalt (Research and material testing institute) - Otto Graf Institut, Stuttgart, according to strict guidelines. It is the prerequisite for the validity of the general approval issued by the construction supervising authority in Germany. Further quality controls range from delamination tests to tests of the quality of glue joints.

French technical approval
AT – 3/02-379
valid until 31 July 2005

At the end of 2002, KLH solid timber boards were approved by the French CSTB (Centre Scientifique et Technique du Bâtiment) as load-bearing wall, ceiling and roof elements.

Application for European technical approval has been filed.

# Technical characteristics

| | |
|---|---|
| Board formats | max. length: 16.50 m - max. width: 2.95 m |
| Board thickness | 3 layers 60, 63, 78, 90, 94, 98, 102, 108 mm<br>5 layers 95, 101, 117, 125, 128, 146, 158, 162, 170, 182 mm<br>7 layers 202, 226, 256 mm |
| Dimensional stability | parallel to board : negligible movement<br>normal to board : 0.2 mm/m per % moisture outside standard 10 to 14% |
| Moisture | 10 to 14 % - technologically dried |
| Fire protection | 0.76 mm/min. - if several layers burn off<br>0.67 mm/min. - if only the cover layer burns off |
| Airtightness | Number of air changes up to passive house standard - depending on the structure of the boards |
| $\alpha$ value | 0.11 to 0.13 W/mK |
| Specific heat capacity | 2.10 kJ/kgK |
| $\rho$ bulk density | 5kN/m³ |
| Thermal mass | Timber wall (with or without plasterboard) 45 to 50 kg/m² |

Based on Austrian technical approval ÖTZ - 1998/137/6

Note: The characteristic values indicated in the general approval issued by the construction supervising authority for Germany and France differ from the ones stated in ÖTZ.

# Material characteristics

| | | |
|---|---|---|
| Modulus of elasticity | 1100 | kN/cm² (boards in bearing direction) |
| $\tau_{adm.}$ | 0.06 | kN/cm² (in relation to gross sectional area) |
| $\sigma_{b\ adm.}$ | 1.1 | kN/cm² (boards in bearing direction) |
| $\sigma_{z,d\ adm.}$ | 1.0 | kN/cm² (boards in bearing direction) |
| $\sigma_{d,L\ adm.}$ | 0.25 | kN/cm² (boards in bearing direction) |

Lateral tensile stress is to be avoided!

The characteristic values for the material have been confirmed via a comprehensive program of tests.

The cross-sectional values can be calculated by omitting the transverse layers of boards. The boards can be built using board thicknesses of 19 to 40 mm (longitudinal layers only 19 and 34 mm).

For further information, please see our statics leaflet.

## Connections on the surface of the boards

The edge of the board is the edge of the component - board mortises do not have to be taken into consideration.

| | | | |
|---|---|---|---|
| Edge distances for screws: | | one below the other and used edge | e = 5d |
| | | unused edge | e = 3d |
| Drift pin and bolt connections | | The grain direction of the top layer is decisive | |
| Nails | from d = 4 mm | Upon pulling out only nails with a load bearing capacity according to class III | |
| Screws | from d = 4 mm | The grain direction of the top layer is decisive | |

## Connections on the narrow ends of the boards

The edge of the board is the edge of the component - board mortises do not have to be taken into consideration.

| | | | |
|---|---|---|---|
| Edge distances: | | one below the other and used edge | e = 5d |
| | | unused edge | e = 3d |
| Screws | from d = 8 mm | - for screws in grain-cut timber, reduce strength of interior surface of opening by 50% | |
| | | - for screws under tension in grain-cut timber, reduce tensile strength by 25% | |

The sizing values have to be determined according the relevant applicable standards and/or approvals.

# Fire protection

KLH solid timber boards were subjected to a fire test at the IBS (Institut for fire protection technology and safety research) in Linz, Austria.
A ceiling element with a thickness of approx. 120 mm was subjected to fire, bearing its full load at the same time. A standard lapped ceiling joint with an integrated compression band was tested simultaneously.
The element was able to withstand the fire load (under full load) for 70 minutes. (The test was then interrupted as deformation had become too pronounced). Gases that permeated through the board (including at the expansion joint) did not become inflamed on the side opposite the fire.
The fire tests showed an average speed of combustion of 0.76 mm/min. That this value is somewhat higher than the value achieved with solid wood is explained by the joints between the strips of the board which were not glued together.
Naturally it is also possible to manufacture F90b elements if they are dimensioned accordingly.
It is recommended that requirements regarding fire protection are established in co-operation with the relevant authorities in the planning phase. The components can then be sized appropriately.

g+p = 7,5 kN/m²


max. deformation l/400

with KLH 5s 182 mm
$v_{max}$=1.1 cm (l/400)
Fire resistance: 60 min.

with KLH 5s 162 mm
$v_{max}$=1.5 cm (l/350)
Fire resistance: 60 min.

g+p = 4,5 kN/m²


max. deformation l/400

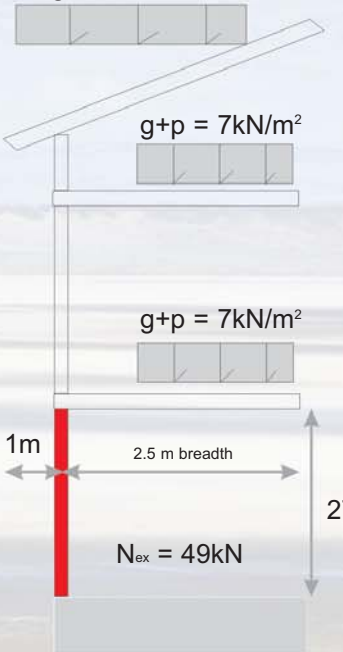
with KLH 5s 146 mm
$v_{max}$=1.1 cm (l/400)
Fire resistance: 60 min

with KLH 5s 128 mm
$v_{max}$=1.5 cm (l/300)
Fire resistance: 60 min

## KLH used for ceilings

The values have been determined on the basis of the latest available tests.

g+s = 4kN/m²




with KLH 3s 94 mm

$N_{adm.}$ = 220kN > $N_{ex.}$
$N_{adm.}$ F30 = 220kN > $N_{ex.}$

with KLH 5s 95 mm

$N_{adm.}$ = 220kN > $N_{ex.}$
$N_{adm.}$ F30 = 120kN > $N_{ex.}$
$N_{adm.}$ F60 = 60kN > $N_{ex.}$

## KLH used for walls

The values have been determined on the basis of the Austrian Ö -standards.

A wall consisting of KLH 5s 95 mm can withstand a fire for 60 minutes (without additional lining materials).

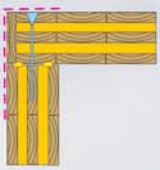
In combination with a fire-resisting plate (F30 at least), a fire resistance period of F60 can also be achieved with KLH 3s 94 mm.

# Construction Guidelines

## Corners

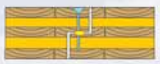
Connection of corners using wood screws as a single-shear connection according to static requirements.

Install convection barrier in the area of the joints.



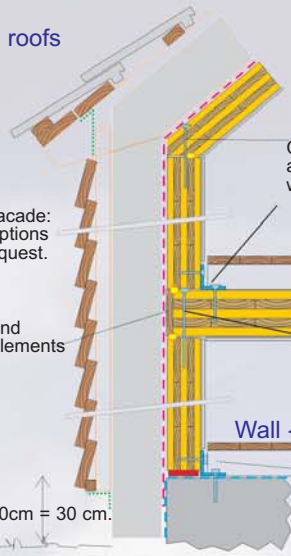
## Ceiling joints

Ceiling joint for minor shear forces and minor superimposed loads that are evenly distributed: Screwed connection in the form of a single-shear connection according to static requirements.

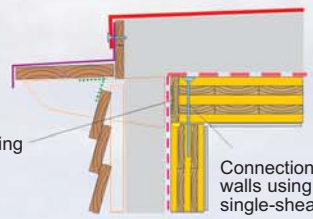


Ceiling joint for higher shear forces: Screwed connection in the form of a single-shear connection according to the static requirements; in the event of major forces and/or if the joint is not flexible enough, it may also be glued.

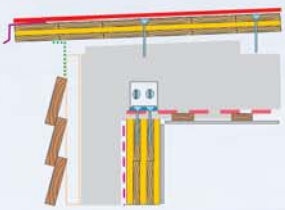
## Steep roofs




## Flat roofs




Flat roof variant for major snow loads or green roofs and/or if a walk-on roof is to be built.




# Guidelines for calculation

KLH solid timber boards are produced in board widths of 225,250, 272 and 295 cm (=width used for calculation). The longitudinal gradation is approx. 100 cm.

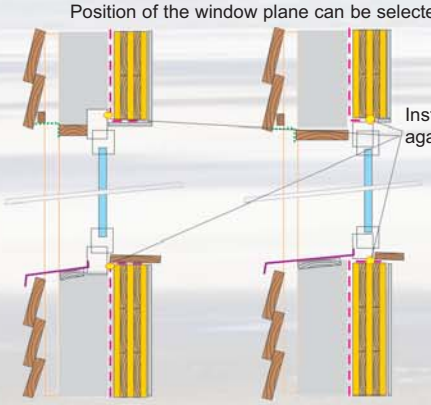
Intermediate measurements will be invoiced at the cost of the next largest element.

When larger quantities are ordered, intermediate widths can also be manufactured on request.

The client will be invoiced for overall rectangular board elements, regardless of cutouts for openings (windows, doors etc). *** These elements may also be delivered to the client on request.***

## Window connections schematic

Position of the window plane can be selected at will.



# Insulation values that can be achieved

When building with KLH solid timber boards, it is most effective to insulate externally. Vapour permeable wall structures with any required k values and/or U values can be built in this way.

KLH load-carrying and space-delimiting board elements can fulfil all static and stiffening functions. An external insulation layer can then be installed; a variety of insulating materials may be used for example rock wool, wood fibres, sheep's wool, etc.

The use of level insulating materials with a high inherent stability is recommended - thereby avoiding the need for intermediate construction. Facades may also be fixed using metal brackets. Various combinations are possible.

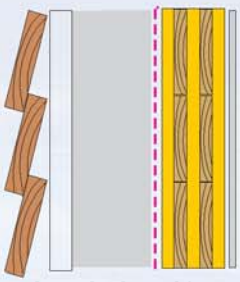
A large variety of constructional standards (industrial, housing, energy-saving, energy-optimised buildings) are possible.

**The examples mentioned below show the thickness of the insulation required for different k values and/or U values. When the thickness remains the same, the k values and/or U values vary to a small extent depending on the type of insulating material that is used.**

A large variety of facade designs is possible, for example, horizontal and vertical timber boardings, wooden boards, plaster systems, metal facades, etc.

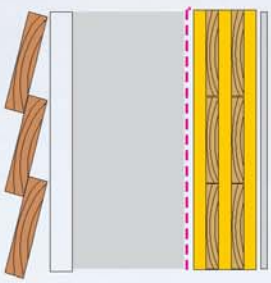
Air tightness is one of the most important criteria that needs to be achieved in a residential building.
KLH solid timber boards are wind-tight from a specific structure with 3 layers and 5 layers onwards. A corresponding attention to joints and connections is necessary; The need for joints can, however, be minimised due to the large size of the individual elements.
End-grain board edges on outside walls always should be sealed and/or clad accordingly.

**k (U) = 0.3 to 0.35**



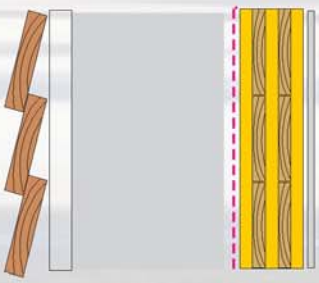
**10 cm insulation** 10 cm timber

**k (U) = 0.2 to 0.25**



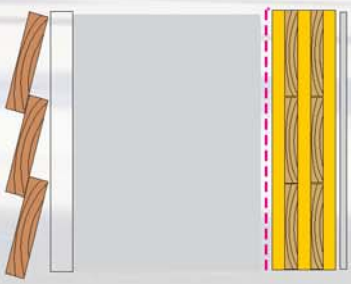
**16 cm insulation** 10 cm timber

**k (U) = 0.17 to 0.21**



**20 cm insulation** 10 cm timber

**etc…**



**xxx cm insulation** 10 cm timber

Depending on the wall structure and/or the type of insulating material and facade, vapour barriers or convection barriers that are permeable to a lesser or higher degree must be installed.
A construction-physics examination of vapour diffusion (condensation risk analysis) is indispensable, in particular for sealed facade systems.

- Large-format construction elements made of solid timber
- Inherently stable and free from distortion
- Solvent-free and formaldehyde-free glue

- Fire behaviour, strength, permeability to air, thermal and sound insulation, vapour diffusion and heat storage have been subjected to comprehensive testing
- Fire protection classes F30 - F90b (according to mass and load)
- Extensive insulation options providing for U values (k values) of less than 0.20

- Self-monitoring and third-party supervision of production
- Research and development works carried out constantly
- Strict quality control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