LIGNOLOC®
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#1 WHITEPAPER

Sustainable from the ground up: The benefits of LIGNOLOC® CLT in solid timber construction

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LCLT VS. CLT:
WHY BUILDERS SHOULD OPT FOR LCLT

In construction, solid wood is used for load-bearing structures such as walls, ceilings and roofs. This offers numerous advantages: In addition to CO_2 storage and the reduction of greenhouse gas emissions, the use of prefabricated solid wood elements enables shorter construction times and high precision.

In addition, the insulation provided by solid wood ensures increased energy efficiency and improved thermal protection. Mass timber buildings are characterized by their aesthetic and flexible design options and create a warm, natural atmosphere.

The use of LIGNOLOC® wooden nails reinforces these advantages. **They turn cross laminated timber (CLT) into LIGNOLOC® CLT (LCLT)**: a purely wood-based construction method that does not require glue or metal fasteners. Unlike conventional CLT or NLT (nail laminated timber).

Keyword „circular economy“: mass timber walls designed as LIGNOLOC® CLT can be completely dismantled. And the possible applications of this sustainable construction method are diverse: they range from multi-story residential buildings to daycare centers and commercial buildings.

Their users enjoy healthy and high-quality living, as LCLT components allow for optimal diffusion and natural regulation of interior humidity, ensuring comfort and well-being.

Wooden nails score points both ecologically and technically: compared to steel nails, they reduce CO_2 emissions by up to 66% and have high tensile and compressive strength due to lignin adhesion. Thanks to their low thermal conductivity, wooden nails improve insulation values and contribute to energy efficiency. In the event of fire, they form a charred protective layer, which improves their behavior.

LIGNOLOC® wooden nails are protected by patents and have EU-wide building approvals that confirm the safety and performance of this innovative fastening method.

„THE STANDOUT FEATURE OF OUR PRODUCT IS ITS SUSTAINABILITY. WITHIN TIMBER CONSTRUCTION, SUSTAINABILITY HAS LONG BEEN A CENTRAL CONCERN. THERE‘S A GROWING DESIRE TO COMBINE WOOD WITH WOOD, PERFECTLY ALIGNING WITH THE CURRENT SPIRIT OF THE TIME.”

STEFAN SIEMERS,
DIRECTOR RESEARCH & DEVELOPMENT, BECK

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COMBINED BENEFITS

LIGNOLOC® WOODEN NAILS IN MASS TIMBER CONSTRUCTION

In mass timber construction, load-bearing elements such as walls, ceilings and roofs are made from solid timber. Compared to traditional timber frame construction, this construction method offers a number of advantages. As a renewable raw material, wood stores CO_2 and therefore helps to reduce greenhouse gas emissions. In addition, mass timber elements can be prefabricated, which shortens the construction time and increases precision. This construction method also enables high energy efficiency, as solid wood has good insulating properties and therefore contributes to the thermal insulation of the building.

Interiors in mass timber construction impress with their aesthetic quality. The visible wood gives the rooms warmth and a natural atmosphere, which can have a positive effect on the well-being of the occupants. Solid timber construction also offers a high degree of design flexibility, as the timber elements are easy to work with and can be adapted to a wide range of architectural requirements.

In contrast, timber frame construction is characterized by a lighter construction and a more flexible room design. However, timber frame construction does not offer the solidity that many builders and architects are looking for in mass timber construction. **LIGNOLOC® wooden nails are a new type of fastening method that significantly expands the possibilities of solid timber construction.**

MINI GLOSSARY

What is Nail Laminated Timber (NLT)?

Nail-Laminated Timber (NLT) is a building material made from stacked wooden boards that are joined together with nails. The boards are aligned parallel to each other.

What is Cross-Laminated Timber (CLT)?

Cross-Laminated Timber (CLT) is a wood composite made from several layers of wood that are glued crosswise to increase structural stability. The layers are aligned alternately in different directions.

What is LIGNOLOC® Cross-Laminated Timber (LCLT)?

With LIGNOLOC® CLT, wood is joined to wood: The crosswise or diagonally laid layers of wood are not joined together with metal nails or adhesive, but by inserting LIGNOLOC® wooden nails (see definition „Lignin adhesion“ on page 6). This creates pure solid wood walls and ceilings made of 100% wood.

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LIGNOLOC® CLT SOLID WOOD WALLS

WOODEN NAILS INSTEAD OF GLUE OR STEEL NAILS!

Mass timber walls become LIGNOLOC® CLT (LCLT) using LIGNOLOC® wooden nails. In contrast to conventional methods such as CLT or NLT, which require either glue (i.e. chemical adhesives) or metal fasteners, LCLT technology enables a purely wood-based construction - with LIGNOLOC® CLT, wood is joined with wood. Everyone benefits from this: timber constructors and craftsmen, the users of the buildings and, of course, the environment:

+ **The craft sector benefits** because the time-consuming and expensive gluing of the individual board layers is no longer necessary. And because fastening with LIGNOLOC® wooden nails eliminates the need for pressing, companies save valuable time during production.
+ **Users of buildings** constructed with LCLT enjoy a healthy home or workplace in pure timber construction - with diffusion-open walls and naturally regulated humidity.
+ And finally, **the environment** - and therefore all of us - benefit because LIGNOLOC® CLT elements are 100% recyclable due to their purity.

LIGNOLOC® CLT: CIRCULAR ECONOMY AND RECYCLABILITY

Utilizing wooden nails in LCLT structures markedly enhances the ease of deconstruction for solid wood walls and ceilings. This allows structures to be effortlessly disassembled at the end of their life cycle, with materials readily available for reuse or recycling. Building elements crafted from LIGNOLOC® CLT thereby uphold the tenets of the circular economy, curbing construction waste while promoting the sustainable utilization of resources.

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DESIGN OPTIONS AND FLEXIBILITY IN THE INTERIOR

Woodworkers know: Furnishings can be easily and securely attached to mass timber walls. The robust structure of these walls allows for the direct installation of heavy objects, such as shelves. Additionally, solid wood walls offer design flexibility: openings for windows or doors can be added later without compromising the wall's structural integrity.

The use of LIGNOLOC® CLT reinforces these advantages: Mass timber walls produced entirely from wood and without metallic elements offer a uniform and natural look - a clear plus for interior construction and design. Thanks to the availability of nails with a stepped shaft, LIGNOLOC® wooden nails are also suitable for precise work in furniture construction or high-quality interior fittings. What's more, there is no risk of hitting metal parts during installations or when making recesses, which prevents tool damage and increases work safety.

"FLEXIBILITY, AESTHETICS, AND SUSTAINABILITY: LIGNOLOC® WOODEN NAILS OFFER NOT ONLY TECHNICAL AND ECOLOGICAL ADVANTAGES IN MASS TIMBER CONSTRUCTION BUT ALSO UNLOCK NEW POSSIBILITIES FOR ARCHITECTURE AND INTERIOR DESIGN."

**MICHAELA BECK,
MARKETING DIRECTOR, BECK**

MASS TIMBER CONSTRUCTIONS FOR ALL TYPES OF BUILDINGS

The applications of LIGNOLOC® CLT span load-bearing and non-load-bearing wall panels, ceiling panels, façade and interior wall cladding. Whether in new constructions or renovations, solid wood construction offers versatility for various building types. In classic single-family homes and multi-story residential buildings, they provide a sustainable and aesthetically pleasing solution that enhances living comfort while meeting modern ecological standards. In commercial buildings, mass timber walls contribute to a positive working environment. In nurseries and schools, they create a natural and conducive learning atmosphere.

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TECHNICAL BENEFITS AND SUSTAINABLE CONSTRUCTION

The ecological benefits are undeniable: LIGNOLOC® wooden nails and LIGNOLOC® CLT represent an environmentally friendly construction method. The production of wooden nails generates up to 66% less CO_2 emissions compared to steel nails, making them a preferred choice for eco-conscious builders. Made from European beech, a renewable raw material, these nails support sustainable forestry and minimize environmental impact.

MECHANICAL PROPERTIES AND PROCESSING

The technical properties of wooden nails in solid timber construction are also remarkable. Wooden nails are characterized by their remarkable strength and offer high tensile and compressive strength, which is essential for the stability of mass timber constructions. A special feature is the lignin adhesion: when the nails are driven in, the frictional heat creates a natural adhesive effect. This bond is exceptionally strong and makes additional fasteners superfluous (see box).

THE WORLD'S FIRST SHOOTABLE WOODEN NAIL

The installation of LIGNOLOC® wooden nails is efficient and time-saving. They are pneumatically inserted into the wood using user-friendly hand tools. As no pre-drilling or gluing is required, the construction process is considerably faster. The wooden nails also protect the tools during reworking. In contrast to metal nails, there is no tool wear, which extends the service life of saws and other tools.

INSULATION VALUES, FIRE BEHAVIOR AND DURABILITY

One physical advantage of LIGNOLOC® wooden nails is the avoidance of thermal bridges. The low thermal conductivity of the beech wood nails improves the insulation values of the entire solid wood wall. This contributes to higher energy efficiency of the building and reduces heating and cooling costs during the ongoing operation of the building. In addition, wooden nails are resistant to corrosion and chemicals. They are therefore also suitable for use in humid environments or in areas that are exposed to chemical substances.

The use of LIGNOLOC® wooden nails also contributes to fire protection in an innovative way. In contrast to metal fasteners, which can quickly loose their strength when exposed to heat, wooden nails behave similarly to the surrounding solid wood in the event of a fire. They form a charred layer on the surface that protects the underlying material from further destruction. In addition, the absence of metal parts eliminates potential thermal bridges, which could contribute to the faster spread of fire and heat with conventional fasteners.

PATENTED VERSATILITY WITH EU-WIDE APPROVAL

The technology behind LIGNOLOC® is patented. This underlines the uniqueness and innovative strength of the product. The safety and performance of the wooden nails has been confirmed by the building authority approval of LIGNOLOC® wooden nails in load-bearing structures by the German Institute for Building Technology (DIBt) since 2020. A milestone for use in timber construction. The extension to an EU-wide approval in 2023 enables the planning, dimensioning and execution of load-bearing connections with LIGNOLOC® wooden nails in all construction projects within the European Union.

LIGNIN ADHESION

The term „lignin adhesion" refers to a bonding process. It occurs when two or more pieces of wood or parts of other lignin-rich materials are heated for a very short time, typically in the millisecond range, to approx. 160 °C or higher and then are pressed together.

The effect of the temperature changes the lignin contained in the material, making it soft and sticky. On cooling, the lignin solidifies again. The two lignin-rich layers that were pressed together during this time remain bonded together by adhesive forces.

The process of lignin adhesion occurs in particular when wooden nails are driven into wood. The surface friction between the nail and the wood matrix causes the surface to heat up to over 160 °C. When the nail is inserted, it displaces the wood matrix, which „pushes back" in response to the nail and strengthens the adhesion.

When driving the LIGNOLOC® wooden nails, ideal conditions with high temperature and flank pressure are created to trigger lignin adhesion. This gives the wooden nail twice the pull-out strength of a geometrically comparable steel nail.

CASE STUDIES

WOODEN PAVILION OF THE UNIVERSITY OF STUTTGART, FEDERAL GARDEN SHOW HEILBRONN, 2019

At the Federal Garden Show in Heilbronn, the University of Stuttgart presented a self-supporting wooden pavilion with a bionic structure. With a span of 30 meters, the shell construction is an architectural masterpiece of digital timber construction, completely digitally designed and manufactured by robots. The pavilion consists of 376 tailor-made individual segments, which are connected to each other by finger joints. The prefabricated components were assembled at the garden show in just ten days. The construction principle - based on the plate skeleton of the sea urchin - was implemented by using hollow segments, each consisting of two plates glued to a wooden frame. To ensure stability during the automated production process, 18,000 LIGNOLOC® wooden nails were used. The beech wood nails were precisely placed by a robot arm and secured the molded parts without significantly increasing the weight. Even during the high-precision milling of the segments, the nails presented no obstacle.

SINGLE-FAMILY HOUSE REISECKER FAMILY, UPPER AUSTRIA, 2021

As part of the modernization of a historic 4-sided farm in the Innviertel (Upper Austria), this new single-family house was built - made entirely of wood and with a special focus on building ecology and recycling management. The clients chose fir as the building material due to its ecological advantages. All materials are installed in such a way that they can be easily dismantled and recycled at the end of their service life. The load-bearing walls of the house were constructed using upright block construction with double tongue and groove and are of visible quality. Diagonal tongue and groove sheathing provides additional bracing. It was attached to the 16 and 12 cm thick block wall elements using LIGNOLOC® wooden nails. The supporting structure of the house is therefore made entirely of wood. This made it possible to dispense with metal fasteners and adhesives. The floor slab, story ceiling and the roof are also made of solid wood. The exterior walls are insulated with 26 cm of cellulose and clad with a rear-ventilated, rough-sawn fir cladding. The windows - also made of fir wood - were inserted into this façade from the outside.

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HOLZ REISECKER STAFF APARTMENTS, UPPER AUSTRIA, 2024

Holz Reisecker sawmill from Upper Austria is constructing a residential building for its employees using mass timber construction, from the floor slab to the roof. This project features six comfortable residential units spread over three floors, built using the upright log construction method. The prefabricated wall elements are made of 15.8 cm solid wood, with the outer walls additionally insulated with 26 cm of cellulose. The backs of the walls are fitted with diagonal tongue and groove sheathing, secured with LIGNOLOC® wooden nails, eliminating the need for glue or metal in the entire wall construction. This design ensures that the building elements can be fully returned to the material cycle. Electrical installations and other details were pre-drilled at the factory, significantly accelerating the construction process. Each day, a residential unit, including sound insulation, could be assembled on-site. The building is scheduled for completion and inauguration in summer 2024.

WOODBLOC

Penzkofer Bau GmbH from Regen in the Bavarian Forest has developed Woodbloc: solid wood walls and durable dowel wood ceilings made entirely from untreated wood, without foils, glue, or chemical additives. The different layers of wood in Woodbloc are securely connected with LIGNOLOC® wooden nails. The factory production of these solid wood elements is fully automated, from laying the boards to nailing them with LIGNOLOC® wooden nails. This method ensures high quality and independence from weather conditions. Woodbloc has already proven effective in several single-family house projects and is also suitable for multi-story residential buildings, commercial buildings, and public buildings.

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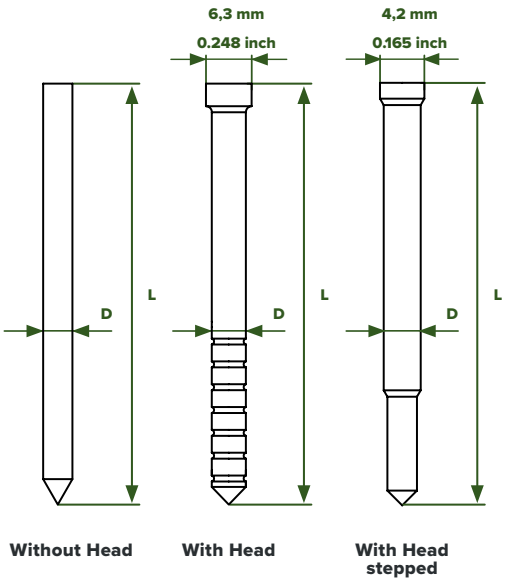
LIGNOLOC® WOODEN NAILS

NAIL SPECIFICATIONS

A Shank Diameter
B Head Diameter
L Length



LENGTH & DIAMETER

L LIGNOLOC® F33 WOODEN NAILS STEPPED WITH HEAD — **D** 3,5 mm | 0.138 inch

- 25 mm | 7/8 inch
- 37 mm | 1 1/2 inch

L LIGNOLOC® F44 WOODEN NAILS — **D** 3,7 mm | 0.146 inch

- 38 mm | 1 1/2 inch
- 50 mm | 2 inch
- 55 mm | 2 1/4 inch
- 60 mm | 2 3/8 inch

L LIGNOLOC® F60 WOODEN NAILS — **D** 4,7 - 5,3 mm | 0.185 - 0.209 inch

- 65 mm | 2 1/2 inch
- 75 mm | 3 inch
- 90 mm | 3 1/2 inch

L LIGNOLOC® F60 WOODEN NAILS WITH HEAD — **D** 4,7 mm | 0.185 inch

- 58 mm | 2 5/16 inch
- 78 mm | 3 1/8 inch

INDIGENOUS BEECH WOOD

THE RAW MATERIAL FOR LIGNOLOC® WOODEN NAILS

Beech is the wood best suited for the manufacturing of LIGNOLOC® wooden nails, because its vertical growth gives it the most homogeneous cell structure. The nail is hardened by compressing the cell structure and permeating it with resin. This also gives the wood tremendous durability both indoors and outdoors. Since beechwood is an indigenous and renewable raw material, this is particularly good for our environmental balance and rounds off our ecological approach to timber construction.

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STANDARDS

NATIONAL TECHNICAL APPROVAL / GENERAL CONSTRUCTION TECHNIQUE PERMIT Z-9.1-899:

On August 28, 2020, the German Institute for Construction Engineering (Deutsches Institut für Bautechnik – DIBt) issued the "National technical approval / general construction technique permit" for "Load-bearing timber connections using LIGNOLOC® wooden nails". The approval enables the planning, design and execution of load-bearing connections in timber frame construction. Planks and panels made of solid timber, wood-based materials or gypsum fiber can be attached to wood building materials using LIGNOLOC® wooden nails. In addition, connections can be made with LIGNOLOC® to produce bracing and load-bearing wall diaphragms.

ETA-23/0041: Our LIGNOLOC® wooden nails without head can be supplied with an European Technical Assessment (ETA) and are officially approved for use in load-bearing connections in all EU member states. On request we would be pleased to provide you with the corresponding documentation.

ETA-23/0330: Our LIGNOLOC® wooden nails without head can be supplied with an European Technical Assessment (ETA) and are officially approved for use in load-bearing connections in all EU member states. On request we would be pleased to provide you with the corresponding documentation.

IAPMO Report #UEL5065: LIGNOLOC® has official IAPMO approval (IAPMO Group). This approval confirms the use of LIGNOLOC® wooden nails for timber-to-timber and panel-to-timer in the USA.

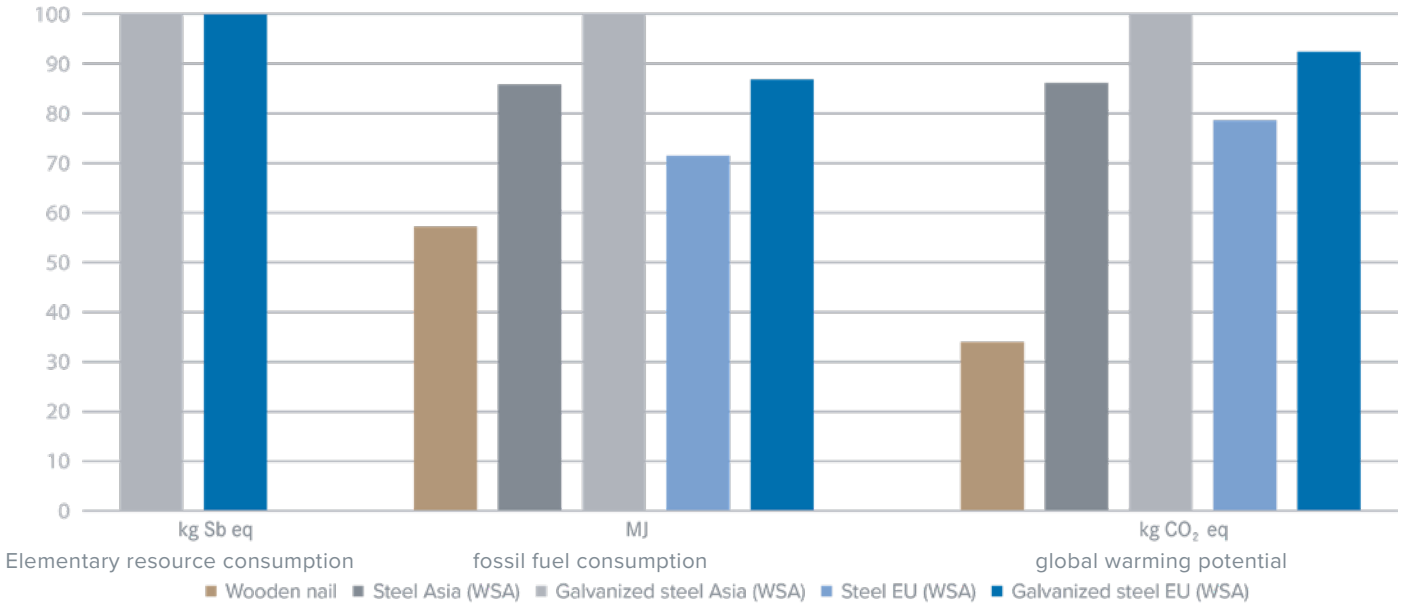
More information at **www.beck-fastening.com**

EXEMPLARY ECOLOGY

66% LESS CO_2

CO_2 EMISSIONS CAN BE REDUCED BY UP TO 66%

From production through recycling, LIGNOLOC® wooden nails distinguish themselves with their environmentally friendly properties. European beech is a renewable raw material with short transport distances. According to a study from the Nova Institute, production of a LIGNOLOC® wooden nail generates only 34% of the greenhouse gases generated by producing a technically comparable steel nail.



The graph shows the relative impact of LIGNOLOC® with 3,7 mm diameter compared to a functionally similar steel nail with 2,8 mm diameter made of European or Asian steel with or without zinc coating. LIGNOLOC® performs better in use of resources of elements and fossil fuels and it has a smaller impact in CO_2 emission. Source: Nova Institute

SUMMARY

LIGNOLOC® wooden nails provide planners, timber construction companies and fabricators with an environmentally friendly, efficient and aesthetically pleasing alternative to conventional fastening methods in mass timber construction.
Made from European beech and with significant environmental benefits: Compared to steel nails, they reduce CO_2 emissions by up to 66%. The pneumatic driving method of the nails not only speeds up the assembly process, but also eliminates the need for pre-drilling and gluing, which considerably simplifies and speeds up the construction process.

The LIGNOLOC® product range includes various diameters and lengths, which enables a wide range of indoor and outdoor applications, both in new and existing buildings. LIGNOLOC® CLT enables the production of metal and glue-free solid wood walls, which are characterized by improved load distribution and a more elastic behavior compared to glued systems (conventional CLT). These properties contribute significantly to structural integrity and adaptability to different load scenarios.

LIGNOLOC® wooden nails are approved throughout the EU and recognized by building authorities, which underlines their reliability and safety in load-bearing (including multi-story) timber construction. In addition, the system is characterized by its excellent properties in terms of thermal conductivity, corrosion resistance and fire protection behavior.

LIGNOLOC® CLT opens up innovative possibilities in mass timber construction that not only promote sustainability, but also offer aesthetic and functional benefits and thus further advance building with wood.

„OUR MISSION IS TO MAKE CONSTRUCTION GREENER, CLEANER AND BETTER. LIGNOLOC® SEAMLESSLY INTEGRATES PERFORMANCE, EFFICIENCY AND SUSTAINABILITY.“

CHRISTIAN BECK, GENERAL MANAGER & CEO, BECK

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Technical data and references
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