

WHITEPAPER #4

Hybrid Construction with Timber in the mix

HYBRID CONSTRUCTION WITH TIMBER IN THE MIX

The use of timber construction has gained increasing popularity in recent years and now appears in many variations. This includes mixed or hybrid construction method. Interestingly, the term “mixed construction” is only used in connection with timber construction – that is, “wood mixed with...”. For example, when reinforced concrete is combined with masonry or steel with concrete, no one tends to refer to this as mixed construction method. So what exactly does “mixed construction” mean when it comes to timber construction? A few possible answers...

When is a mixed construction really a mixed construction?

Originally, the term “mixed construction method” was used to describe composite construction methods, such as those combining timber and concrete, which have existed for decades. Timber-concrete composite ceilings are an efficient solution that combines the qualities of two building materials, unlocking new construction possibilities – for instance, achieving greater span widths with thinner structural components, along with improved soundproofing compared to either material alone.

Today, however, construction experts also refer to mixed or hybrid construction method when materials are combined without forming a composite structure, like those seen in timber-concrete composite ceilings. In this sense, traditional half-timbered buildings are also considered mixed constructions since they use timber as the load-bearing structure and masonry for infill. This means that timber constructions can be erected as independent load-bearing structures and at the same time “mixed” with mineral building elements in such a way that they optimally complement each other’s advantages.

This type of mixed construction method has become increasingly common in recent years, whether for extensions, additions, single-family homes, multi-storey residential buildings or commercial buildings. Timber construction is used wherever planners find it most suitable. For the remaining parts, they rely on mineral-based building materials.

However, the point at which a combination of materials qualifies a building as a “mixed construction” is often subjective. After all, the boundaries are fluid. This raises the question of whether mineral buildings with a timber roof structure – as is common in most single-family homes, multi-family houses, commercial buildings, and sports halls – should be considered mixed constructions. They are rarely referred to as such.

USING TIMBER WHERE IT PERFORMS BEST

Fundamentally, good architects and engineers are expected to use building materials where their properties are best suited for the specific structural requirements of the building.

The **Visitor and Information Centre (BIZ) of the Black Forest National Park** (Germany) is located at the “Ruhestein” mountain pass, surrounded by a unique landscape. Its spectacular design, featuring crossed and stacked tubes, is an analogy to fallen trees lying on top of one another (see image bottom left). The designers mastered the project using various building materials, with wood taking centre stage.

The timber frame girders made of beech veneer laminated timber – also known as Baubuche – were clad with cross-laminated timber panels, divided horizontally for window bands (see image bottom centre) and as full-height wall elements within the timber frame. A view of an intersection area of two “tubes” reveals a particularly complex load situation (see image bottom right). Here, steel trusses were used as transfer beams, along with hollow core elements for the floor, walls, and ceiling or roof.



The **Summit Restaurant on the Weisshorn** near Arosa (Switzerland) is a mixed construction made of concrete, steel, and wood. The timber construction elements primarily provide bracing for the steel structure and the entire building.



The office building of the boiler manufacturer **ÖkoFen** in Mickhausen, Bavaria (Germany), is a mixed construction featuring reinforced concrete props and ceilings combined with pre-fabricated timber frame exterior wall elements.



The **retirement home** in Teufen (Switzerland): The façade consists of a concrete façade grid, the compartments of which are filled with wooden elements, so-called panels. Cross-laminated timber walls were used for the internal structure and hollow core elements for the ceilings.



Prefabricated timber façade elements for energy-efficient renovations can transform originally mineral-based buildings into hybrid structures. These elements can either be mounted directly onto the old façade like a second skin or replace the exterior walls after demolition.



Timber extensions added to originally mineral-based buildings also turn them into hybrid structures.

Aerial view of the new **ERBE** production, logistics and administration building in Rangendingen (Germany) shows the various building sections. The manufacturer and developer of endoscopic and surgical devices and instruments built a new competence centre that combines production, product development, logistics, and administration in one complex. It was important to the client to invest in a building that is ecologically, economically and socially sustainable. Therefore, the roof structures and façades of the entire complex were constructed using timber.



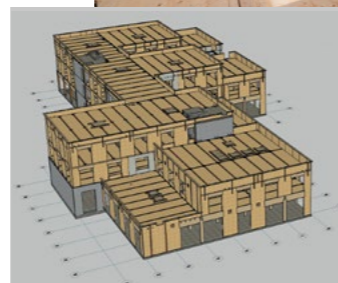
The roof structure of the production hall (the building section at the back, away from the street, shown on the left in the image) is composed of glulam main and secondary beams, braced with diagonals, and features an offset along the hall's length.

The system mix makes the difference

Essentially, the choice of structural framework and building materials depends on the building type, its span widths, as well as fire protection, thermal insulation, soundproofing and many other factors. Finding the best possible common ground is the challenge for every planner and often depends on their knowledge of building materials and construction systems. This is especially true in engineered timber construction and modern timber house building. In addition to combining timber construction with steel or reinforced concrete structures, various timber construction systems and methods can also be combined. For instance, it's quite common for timber frame or timber skeleton construction to be combined with cross-laminated timber ceilings and wall panels for structural reasons, fire protection requirements, or other design needs, forming a system mix.

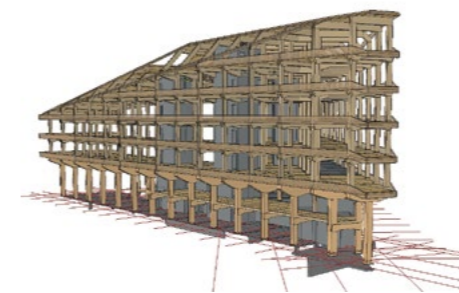
CONCLUSION: Whether building with or without wood, planners must carefully consider all material options in relation to the building type and its requirements to determine the optimal solution. And most importantly, to ensure the best possible execution of the design and functionality of the building!

The new building ensemble on the campus of **University of Witten/Herdecke** is considered one of the most sustainable university buildings in Germany. The staggered timber structure stands atop a solid hillside base and offers maximum flexibility of use through its structural design. Inside, a timber skeleton forms the load-bearing framework, while cross-laminated timber (CLT) elements make up the ceilings, roof, and building envelope. The props, notched at their upper ends, support the glulam beams on both sides. The projecting "residual cross-section" fits into corresponding recesses in the ceiling elements during assembly.



The top of the A-shaped **Bank building of SR-Bank** in Stavanger (Norway) rises seven storeys high and slopes down to four storeys at the rear. The floors above the two-story entrance level cantilever on both sides, allowing for additional floor space. This had significant implications for the structural design.

The 3D CAD model of the structure (bottom left) shows that the above-ground load-bearing framework is mainly a timber skeleton structure. It features props and beam pairs made of beech veneer laminated timber (Baubuche) on the lower two floors and glulam beams on the upper floors, along with cross-laminated timber ceilings.

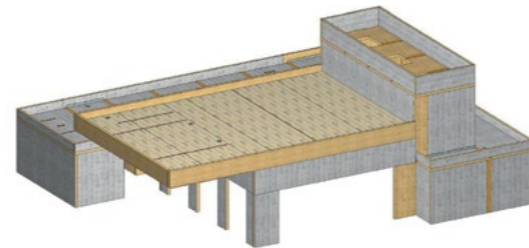


The **"little flat iron"** in Leipzig is the first five-storey residential and commercial building in solid timber construction in the German state of Saxony (bottom left). Shaped like a wedge to fit the pointed corner plot, its distinctive design makes it a visual highlight. The façade with its horizontal bands of windows, sliding shutters and pre-greyed larch wood cladding defines the character of the building.

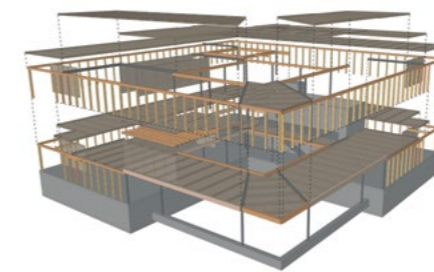
3D isometric view of the timber skeleton structure with glulam ceilings and walls, as well as building components made of reinforced concrete (bottom right image). The timber skeleton construction, featuring glulam props and beams, is clearly visible (bottom centre image). Cross-laminated timber (CLT) ceilings and walls form stiffening diaphragms, which are inserted field by field between the beams and props.



The new **funeral hall** at the Mergeläcker cemetery in the Wolfartsweier district of Karlsruhe (Germany) is a simple yet elegant wooden building. The shingle cladding gives the building a homogeneous and warm appearance. Bottom right: The isometric view of the load-bearing structure, made from cross-laminated timber panels and diaphragms, as well as glulam attic beams for the large cantilevered roof (the freestanding wall in front of the chapel room is not shown here).



The two-storey **Town Hall in Hainburg** (Germany) is characterised by its clearly structured façades. Built on nearly a square footprint, the building greets visitors under its elevated corner, which is recessed atrium-like, providing plenty of light and air. The exploded-view drawing shows the material and system mix: The post-and-beam structure along the façades, the stiffening cross-laminated timber wall and ceiling elements, and the corner solution for the bridge-like beams over the entrance area with steel props and beams, as well as cross-laminated timber infill panels.



In the heart of Augsburg (Germany), the **Fuggerei Pavillon**, stood for several weeks on the Town Hall Square to celebrate the 500th anniversary of the world's oldest social housing complex. This striking structure is a reinterpretation of a typical Fuggerei residential house with a gabled roof. The cross-laminated timber elements of the cantilever, up to 24 cm thick, were craned into place and had to be precisely measured, aligned, and assembled.



The **tower for ski-jump judges and trainers** in Oberhof, Thuringia, is a shining example of how even unusual buildings can be created with wood. It was not only the striking geometry of this 14.90-metre-wide special structure, with a depth varying between 3.80 and 6.70 metres and an elliptical-like floor plan with rounded narrow ends, that challenged the structural engineers. The staggered, load-bearing walls on each floor and the bay window on the second floor, extending up to 3 metres, also posed significant design challenges. The building was constructed as a three-storey, solid wood structure made entirely of cross-laminated timber, resting on a reinforced concrete base floor.

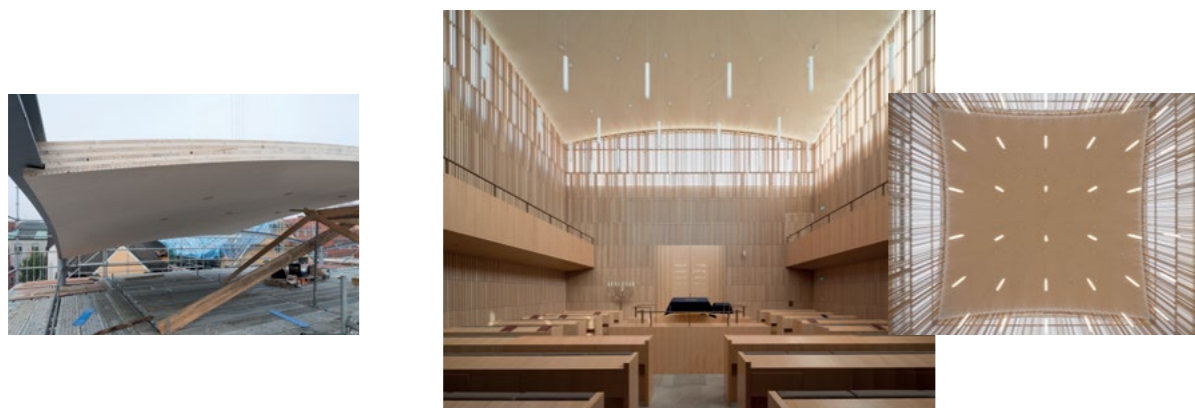


The “**Paneum**” customer information centre and event forum, created by the Backaldrin company in Asten, Upper Austria, consists of two main architectural elements: a cuboid base building and an elevated, freely shaped, silver-shimmering superstructure. Whether seen as a cloud, meringue, dough piece, or two stacked loaves of bread, the design leaves plenty of room for interpretation.

A self-supporting cross-laminated timber structure forms the freeform shell of the “Wunderkammer des Brotes”. A steel staircase spirals up the centre of the four-storey building, connecting the levels. The complex freeform structure was digitally designed on a computer. The data was then transferred directly to the manufacturing machines, where the layered elements were milled and later assembled in Asten.



For the **Synagogue** of the new Jewish community centre in Regensburg, Germany, a subtle exterior yet atmospheric interior roofing solution was required. The answer was found in a flat domed shell made of doubly curved cross-laminated timber. Arch-shaped steel profiles frame the cross-laminated timber segments of the roof, serving as structural supports. These elements were optimally positioned on the edge beams via milled grooves, ensuring that the load-bearing components remain hidden from view.



STRONG DUO IN COMBINATION

An overview of timber-concrete composite constructions and their applications

Timber-concrete composite ceilings can be a good alternative to pure reinforced concrete or timber ceilings. The material combination not only combines the advantages of both building materials, but hybrid ceilings also offer additional benefits in the form of low weight, simple connection details, as well as good soundproofing and fire protection properties, both in new construction and when building in existing structures.

The timber-concrete composite (TCC) construction method is based on the idea of combining the advantages of both materials: wood takes on the tensile forces, while concrete handles the compressive forces. In this hybrid construction method, a thin concrete slab, with a thickness starting from 6 cm, is coupled with wooden beams, a cross-laminated timber (CLT) panel, or a wood-based panel using connecting elements – typically made of steel. These elements create a shear-resistant and load-bearing bond between the two components.

This construction method was first applied in the renovation of wooden beam ceilings, which needed to be reinforced for reasons such as insufficient load-bearing capacity, inadequate stiffness, or undesirable vibration behaviour. Moreover, the timber-concrete composite (TCC) construction method improves sound and fire protection due to the additional mass provided by the concrete. After countless such renovations, TCC ceilings have also been regularly used for many years in the new construction of multi-story residential buildings, hotels, schools, other public buildings, and industrial buildings.

ENSURING OPTIMAL COMPOSITE ACTION

The most important element in ensuring the composite action between timber and concrete are the connecting elements used between the two materials. The bond can be created using screws, nails, bolts, or steel and shear connectors of various designs. Also commonly used are bonded perforated metal strips, also known as wood-steel adhesive (WSA) connections. In addition to steel connectors, the bond can also be created in combination with specific cut-outs (notch) in the cross-laminated timber (CLT) panels or glued laminated timber (glulam) beams, so that the poured concrete interlocks with them once it has hardened.

SIMPLE SOLUTION FOR RENOVATIONS AND NEW BUILDINGS

A relatively simple solution is, for example, the use of screws, which are cross-placed and offset into the ceiling beams or ceiling slabs. This variant made the timber-concrete composite (TCC) construction method an accepted, independent, and economical building method, both in the renovation of old buildings and in new constructions.

In ceiling renovations, the ceiling structure often consists of a beam layer with continuous formwork, an intermediate floor filled with sand or slag, and a gypsum or timber ceiling. To keep the old ceiling dry during the subsequent concrete topping and ensure the so-called concreting tightness, a separation layer, usually a PE film, must be laid on the ceiling. Then, composite screws can be placed in pairs, offset and angled – typically at 45° – through the top formwork into the timber beams (or the solid wood ceiling) for optimal composite action. After adding further reinforcement elements, the whole structure can be poured with concrete. By connecting the timber beams with the concrete ceiling, the linear bending behaviour of the timber beams changes, transitioning into a combined surface load-bearing behaviour, which increases the stiffness of the ceiling.

The specific installation methods for the different types of composite screws are outlined in the relevant general building authority approvals (allgemeine bauaufsichtliche Zulassungen/abZ). The key factors for the proper functioning of the composite are primarily the angle of inclination, the set depth, and the minimum permissible distances between the screws.

Before starting such renovation and strengthening measures for existing ceiling structures, the condition of the existing beam layer must be examined and appropriately considered in the planning. Additionally, to prevent any deformations during the construction process, it is necessary to support the ceiling with props until it has reached sufficient concrete strength.

TIMBER-BEAM-CONCRETE COMPOSITE CEILINGS FOR NEW BUILDINGS

As the first newly constructed projects using the “timber beam with concrete ceiling” composite system, two buildings in the German-speaking countries attracted significant attention at the time of their creation: the eight-storey LifeCycleTower (LCT One) in Dornbirn and the five-storey administrative building Illwerke Zentrum Montafon (IZM), both in Austria, both designed by architect Hermann Kaufmann, and both featuring timber-frame structures with TCC floors in their new build version. In both the LCT One and IZM, the concrete was poured wet onto the beams using formwork, and the bond between the timber and concrete was achieved on-site using knobs and steel connectors or notches and screws.

A more recent example of the “timber beam with concrete ceiling” composite system is the Innovation and Application Centre of adhesive manufacturer Jowat in Detmold. Here, the floor slab in the laboratory and office wing was not only constructed as a timber-concrete composite (TCC) ceiling, but it is also one of the largest of its kind, with a span width of nearly 15 metres. It combines 40 cm wide and 68 cm high, block-glued laminated timber (glulam) beams with overlaid three-layer panels, followed by a 14 cm thick concrete layer with reinforcement as the top layer. The beam tops were milled in a zipper-like fashion, creating shear connectors and notches. Milled shear connectors

at the edges of the beams allowed the three-layer panels to be laid as lost formwork, flush with the shear connectors, similar to a console. The notches and shear connectors with washer-head screws (see also info box on p. 18) create the interlocking and shear-resistant bond between the timber and concrete.

AVOIDING WET CONCRETE POURING ON SITE WITH PRECAST CONCRETE ELEMENTS

Returning to the LCT One and IZM projects, the architects and engineers developed the timber-concrete composite (TCC) ceiling further from the experiences of these two projects into a dry-installation version. This version was then used in the two-storey office building of Wagner in Nüziders, Austria: precast concrete slabs, which are connected to the timber beams on-site using special connectors – the KVB connectors – in a dry construction method. This approach allowed the planners to develop an economical and highly efficient construction method, which also avoids introducing moisture into the timber construction, as is the case with wet concrete pouring on-site.

This is particularly important in timber constructions and was a key deciding factor, for example, in the interim building “Globe Theater” in Coburg, Germany, which was completed in autumn 2023. However, the floor slabs of the theater building are, unlike in the office building in Nüziders, a combination of cross-laminated timber (CLT) elements and precast concrete panels, connected by KVB connectors. Another advantage of the method of dry-connecting the “wood” and “concrete” components is the ability to separate the timber construction and concrete construction trades.

The KVB connectors enable the dry connection in combination with self-drilling screws (Würth ASSY plus VG screw, ETA 11/0190). Together, they ensure that the concrete slabs and timber beam or wooden panel are force-fit and shear-resistant connected. The KVB connector acts as a placeholder, meaning it keeps the path clear for the screw to be later screwed in during the pouring of the precast slab, and also functions as a guide sleeve. This method allows the ceiling to be formed as a plate and to take on horizontal forces through the precast slabs.

The larger screw diameters and lengths compared to traditional pin-shaped connectors, combined with the shallow insertion angle (30°), increase the load-bearing capacity of the individual connection. As a result, the total number of connectors required can be significantly reduced compared to classic timber-concrete composite (TCC) ceilings with diagonally inserted screws in wet concrete pouring. Once the screws are installed, the TCC ceiling reaches its full load-bearing capacity. Furthermore, due to the dry installation method, the installation of a separation layer becomes unnecessary. An elaborate supporting of the timber structure along with formwork or curing times on-site for the setting of the concrete are now a thing of the past.

Instead, a hybrid solution combining dry installation and wet pouring was used in the design of the timber-concrete composite (TCC) ceilings of the research building “Centre for Light and Environmentally Friendly Construction (ZELUBA®)” on the campus of Braunschweig Technical University (TU Braunschweig), Germany: Glulam beams were fitted with reinforced concrete semi-precast elements, which the planners had dimensioned differently depending on the floor level. The beams are spaced at 1.25 m intervals, and the 1.25 m wide precast slabs each cover a beam field.

Diagonally inserted fully threaded screws couple them shear-resistant with the concrete ceiling. On-site, these were connected into a ceiling slab by pouring concrete into the joint gaps after laying the additional reinforcement. Since the ceiling above the ground floor had to meet higher vibration sensitivity requirements “against human-induced excitation” due to the laboratories on the first floor, the timber beams were made taller, and the filigree ceiling panel was dimensioned thicker in this area.

OSB, CROSS-LAMINATED TIMBER (CLT), AND BEECH WOOD PANELS AS HIGH-LOAD-BEARING COMPOSITE MATERIALS

At the National Park Centre “Haus der Berge” in Berchtesgaden (Germany), another variant of the timber beam ceiling with concrete slab (in wet concrete pouring) was used: Due to the span widths of up to 16 metres, high traffic loads, and very high soundproofing requirements, the planners opted for a plate beam made from a 40 mm thick OSB panel and glulam beams, combined with a concrete slab.

To construct the ceiling, the OSB panels (OSB 4) were factory-joined using a screw-press adhesive bonding with four beams each, creating 2.5-metre wide and up to 16 metres long Pi-plate elements. This was done while considering a camber to counteract deflection after pouring the concrete and the effect of concrete creep. To create the bond, the OSB panels received screws on the top side, as well as notches transverse to the glulam beams.

After pouring the concrete on-site, the concrete interlocks with the panel and screws, so that under load, the concrete strips engage with the notches, creating a mechanical interlock. This interplay allows the concrete slab to absorb large forces. As a result, the forces to be transmitted through the screws are smaller, which also leads to a reduced need for screws.

The “House of Natural Resources” (HoNR) on the ETH Zurich campus in Zurich (Switzerland), which serves the university not only as an innovative office building but also as a research lab for sustainable construction, features an TCC ceiling made from beech veneer laminated timber (Baubuche). The bond is achieved by mechanically interlocking the 15 mm deep notches with the concrete.

This type of ceiling was then also used in four and five-storey residential buildings in a perimeter block development in timber hybrid construction at Pistoriusplatz in Berlin. For design reasons, only Baubuche panels with a different surface appearance to the HoNR were chosen here: Instead of Baubuche-Q panels, Baubuche-Fineline panels were used in Berlin. The TCC ceilings, with 6 cm of Baubuche and a 12 cm concrete layer, span width 6 metres. However, the composite ceilings were only allowed to be used based on individual approval. For this type of ceiling construction, cross-laminated timber or glulam panels have typically been used instead of Baubuche panels.

PERSPECTIVE: THE ADHESIVE BOND OF WOOD AND CONCRETE

Until now, the adhesive bond between wood and concrete has been a missing variant in composite construction. However, this method has been under research for several years, aiming to develop a new, efficient, and cost-effective bonding technique. For instance, Holzforschung Austria in Vienna, Austria, has been working for some time on fully bonding cross-laminated timber (CLT) with pre-fabricated concrete panels.

Additionally, the Fraunhofer Institute WKI, together with Technische Universität Braunschweig and University of Kassel in Germany, has developed a rapid adhesive technique for bonding timber construction elements with concrete precast panels. Furthermore, at Technische Universität Berlin (Germany), a wet-on-wet adhesive technique (NinN-Kleb-HBV TCC) is being researched in collaboration with Cordes Holzbau, and the Institute for Timber Construction at University of Augsburg (Germany), in cooperation with two industry partners (project collaboration ForCYCLE II – Sub-project 04, see web tips), is conducting promising research projects. These results are expected to be further refined and gradually prepared for practical application.

TIMBER-CONCRETE COMPOSITE SOON TO BE TECHNICALLY REGULATED?

The planning, design, and implementation of timber-concrete composite (TCC) construction methods are not yet fully technically regulated. Until now, ceiling structures have mainly been designed based on the approval of the bonding agents. The German Institute for Structural Engineering (DIBt) issues general type approvals when no specific technical regulations exist for construction products and no generally accepted rules of technology are available. These are available on the DIBt website (see web tips).

As the importance of this type of construction is increasing, the future version of EN 1995 (Eurocode 5:2022, EC 5 for short) will also regulate the TCC construction method. As a first step, the Technical Specification DIN CEN/TS 19103 was created, which can serve as a basis for the future standardization of TCC components. It remains to be seen when the new EC 5 will be ready.

CONCLUSION: TCC constructions are a mature and proven construction method. The combination of the material advantages of wood and concrete offers excellent alternatives in both renovation and new construction. The high requirements for load-bearing capacity, soundproofing, fire resistance, and vibration behaviour can be effectively met with TCC constructions. Therefore, it is worth considering this construction method for many projects and assessing its potential applications on a project-specific basis. A significant influence on the cost-effectiveness is the bonding material used, with its respective price-performance ratio. This is made up of the material cost, the processing effort, and the technical performance capabilities.

Web tips:

Further information on the projects mentioned in the text can be found here:

Final report on:

fnr.de under the funding codes 22008917 and 22010717

or

“building with wood” <https://tinyurl.com/2t4hh52n>, at the bottom of the report

Project network ForCYCLE II - sub-project 04:

<https://tinyurl.com/yckth385> and

<https://tinyurl.com/2s4785af>

DIBt type approvals:

<https://tinyurl.com/4vch46r6>

INFO

NEWS ON THE SUBJECT OF ‘LIFT-OFF LOCK’

With the new **KVB connector** from REISSER, the first lift-off lock with approval for TCC ceilings with birdsmouth joint design has been available since the end of 2023. The load-bearing capacity of lift-off locks in TCC constructions, which was previously not clearly regulated by the standard, is now clearly regulated for such a fastener for the first time by the new general type approval (aBG) of the KVB connector (Z-9.1-916).

Link to Z-9.1-916: <https://tinyurl.com/5hyyv7un>

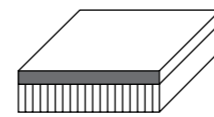
Further information at: <https://reisser-screws.com/news/detail/kvb-verbinder/>

At **Bürobau Wagner** in Nüziders, Austria, 7.20 m and 2.30 m wide precast slabs were laid over two bays of beams. The longitudinal edges of the panels lie on the beam axes. Glulam beams and precast slabs are flush with the surface.

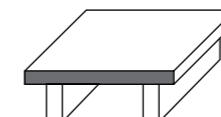


Types of cross-section

Panel



Panel beam

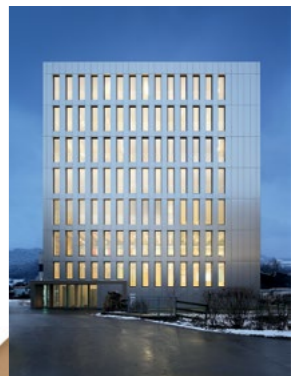


Timber-concrete composite ceilings can be made with full-surface wooden elements or wooden beams.

Diagonally and offset inserted screws: Crossed screws inserted at an angle of less than 45° (to absorb shear forces), as well as reinforcement mats as supplementary elements, are among the classic methods of creating the bond between wood and concrete after pouring the concrete onto the wooden panel.



The eight-storey **LifeCycle Tower (LCT One)** in Dornbirn (Austria) was, at the time of its construction, a prototype for material- and time-efficient and therefore economical construction with standardized, repetitive components using timber-concrete composite ceilings. These were later technically developed for dry bonding with KVB connectors.



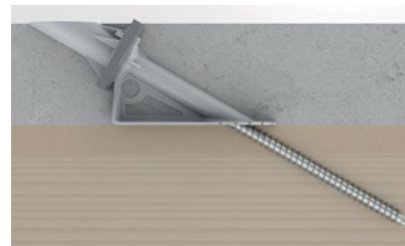
The timber-concrete composite elements for the LCT One were traditionally cast on-site concrete and then dry-installed as finished elements.



The beam tops of the timber-concrete composite ceiling at the **Jowat application centre** in Detmold (Germany) were milled out like a zipper to create shear connectors and notches. The milled edges of the shear connectors allow the three-layer boards to be laid between the beams. The notches and shear connectors (the raised part of the beam milling, unlike usual) with washer-headed screws for securing against lifting create the bond between wood and concrete (see also information box, page 18).

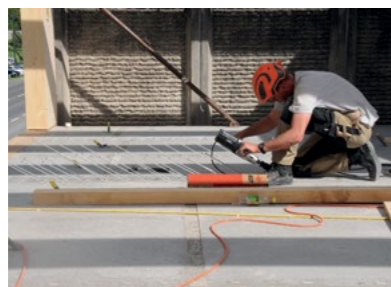


Due to the beams remaining visible beneath the timber-concrete composite ceiling, all joints had to be sealed to prevent cement slurry from seeping through. The timber-concrete composite ceiling from the Jowat Application Centre combines glulam wood beams, three-layer panels and a reinforced concrete layer.



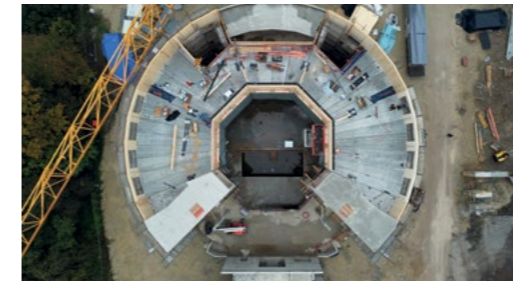
The KVB connector is already embedded in the ceiling elements at the precast concrete plant (with a wood interlayer for panel thicknesses > 7 cm).

With the help of KVB connectors, timber beams or wooden panels can be joined on-site to the precast concrete slabs via screws, forming a composite beam.



The connection between the prefabricated concrete panels and the wooden beams, creating a shear-resistant timber-concrete composite ceiling, is achieved dry through the screws passing through the embedded KVB connectors.

The prefabricated concrete panels, with their underside visible after installation, combined with the glulam wood beams and girders, provide both an aesthetically pleasing and clean solution.



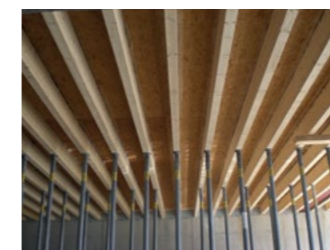
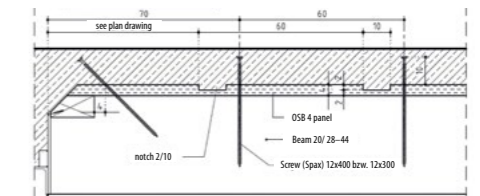
Aerial view of the third floor of the **Globe Theaters in Cloburg** (Germany) during the laying and screwing of the pie-shaped precast concrete elements onto the cross-laminated timber panels below.

At the **ZELUBA Braunschweig** (Germany): Diagonally screwed full-thread screws (located in the joint seams of the subsequently laid 1.25-metre wide precast panels) are inserted into the longitudinal axis of the beams ($e = 1.25$ m). These, along with the additional reinforcement added later on the ceiling, connect the panels and beams to form a shear-resistant ceiling disk after the concrete pouring.



At the **National Park Centre "Haus der Berge"** in Berchtesgaden (Germany), the large-format panels enabled the prefabrication of large ceiling elements. Milled notches and screwed fasteners create the simple bond between concrete and wood.

Standard detail of timber-concrete composite ceilings with notches and screws as bonding elements, as used at the National Park Centre "Haus der Berge."



At the National Park Centre "Haus der Berge" in Berchtesgaden, the screw-press glued Pi-panel, consisting of glulam timber beams and OSB 4 panels, was supported from the underside for the application of the concrete.

An unconventional type of timber-concrete composite was used at the National Park Centre "Haus der Berge": glulam timber beams with OSB 4 panels and an overlay of concrete.



BUILDING UPWARDS WITH CROSS-LAMINATED TIMBER & MORE

Timber construction is booming

The rapid development of modern timber construction in the last few decades is increasingly reflected in multi-storey buildings. The number of high-rise timber buildings is growing worldwide. Not least because they are considered climate-friendly. Here is an overview.

TIMBER CONSTRUCTION HAS BEEN POLITICALLY BACKED AND PROMOTED FOR YEARS

Modern timber construction is gaining importance, especially in the context of the need to build resource-efficient, energy-efficient, and climate-friendly structures. Compared to conventional building materials like steel, reinforced concrete, brick, glass, and aluminum, working with wood requires significantly less primary energy. As a renewable raw material, timber enables an eco-friendly approach to construction, supporting efforts to advance the energy transition. This concept has gained wide acceptance – among planners, the industry, politicians, and the general public.

As a result, an increasing number of private builders, investors, and architects are becoming interested in the renewable raw material. In recent years, many of them have developed new ideas and concepts for timber constructions, particularly for timber high-rises, demonstrating how the advantages of this construction method can be harnessed to create additional living space in cities while also enhancing the quality of life and living conditions. As a result, public authorities are also increasingly and deliberately turning to wood in their building projects.

WOODEN SKYSCRAPERS GAINING HEIGHT WORLDWIDE

In this context, many energy- and material-efficient multi-story residential, office, and administrative buildings made of wood have been built in major urban centres worldwide in recent years. Impressive high-rises, either entirely or partially constructed from wood, have also emerged in countries such as Canada, Australia, England, the USA, Finland and Norway. The world record was long held by the 18-storey, 85.40 m high “Mjøsa Tower” **Mjøstårnet** in Brumunddal, Norway, by Voll Arkitekter from Trondheim (Norway). The building made of wooden modules stands on the shore of Norway’s largest lake, Mjøsa, and houses offices, apartments and a hotel. With the completion of the **25-storey Ascent in Milwaukee** (USA) by Korb + Associates Architects from Milwaukee, this building then became the new record holder at 86.60 m.

But a lot has also happened in the German-speaking countries, and much more is yet to come. The 34 m high “**Skaio**” in Heilbronn, designed by the Berlin architecture firm Kaden+Lager (now Kaden+ and Lager-Schwertfeger), has been Germany’s tallest timber (hybrid) high-rise so far. Now, it faces competition from the 65 m high “**Roots**” in Hamburg’s Hafencity. This building, also known under the working title “Wildspitze Hamburg,” was designed by the Hamburg architecture firm Störmer Murphy and Partners. Another contender is the 98 m high hybrid timber high-rise for the district administration in Karlsruhe, which is currently under construction. In 2026, it is expected to be joined by the “**WoHo**,” a 98 m high, 29-story residential timber high-rise in Berlin-Kreuzberg. This project is being developed by Mad Arkitekter from Oslo and UTB Projektmanagement GmbH from Berlin. These timber high-rises in Europe are mostly hybrid constructions. However, the majority of multi-story buildings fall into the category of mid-rise structures, typically belonging to building classes (GK) 4 and 5*.

INFO

The new **MusterHolzbauRichtlinie** (MHolzBauR) (Model Timber Construction Guideline) now provides comprehensive regulations for using timber as a building material up to the high-rise threshold, generally up to eight stories. These regulations now fully apply to timber panel construction as well. In addition to new buildings, the directive also allows for vertical extensions and external wall cladding made of timber on existing exterior walls. Special-purpose buildings are no longer generally excluded either.

Proven online resources

for specialist planners, which are regularly updated:

www.brandschutznavigator.de

www.dataholz.eu

Planning aid

Informationsdienstholz brochure: “Guide Details for Component Connections GK 4 and 5”:

<https://informationsdienst-holz.de/publikationen/leitdetails-fuer-bauteilanschluesse-gebaeudeklasse-4-und-5>

* The aim with GK 4 and 5 was and is to be able to plan and build simply. To make this possible in Germany in the future, research was conducted, and discussions were held with building authorities and fire departments. This facilitated the advancement of building regulations. In this context, the collaborative research project TIMpuls, involving TU Munich, TU Braunschweig, Magdeburg-Stendal University of Applied Sciences, and the Institute for Fire and Disaster Protection Heyrothsberge, should be mentioned. Extensive experimental and numerical studies provided the foundation for updating building authority fire protection regulations to enable the expanded use of multi-story timber construction. Final report by TIMpuls can be downloaded at: <https://doi.org/10.14459/2022md1661419>

Switzerland is also reaching new heights. An 85-metre-high wooden building called “**Tilia Tower**” is currently under construction in Lausanne. It was designed jointly by the Danish architecture firm 3XN and IttenBrechtbühl from Bern. The completion of the tower is scheduled for 2026. In Zug, V-ZUG Immobilien is building another landmark in wooden high-rise construction. The 27-story, 80-metre-high “**Projekt Pi**” by Duplex Architekten from Zurich will become the tallest wooden high-rise in Switzerland.

It should be mentioned here that the first ‘real’ timber high-rise building in Switzerland was the ten-storey office building “S22” by Burkard Meyer Architekten from Baden on the Suurstoffi site in Risch-Rotkreuz in the canton of Zug. Completed in the summer of 2018, it was not only Switzerland’s first “real” timber high-rise, but also the first in the entire German-speaking region. Austria soon followed suit with its 84-m wooden skyscraper, known as “**HoHo**,” designed by Rüdiger Lainer + Partner Architects from Vienna, located in Seestadt Aspern near Vienna, setting a new height record.

The Netherlands also have some impressive height in wooden building construction. In March 2022, the 73-metre-high residential tower with 21 floors, named “**HAUT**” was completed in Amsterdam by Team V Architectuur. In Rotterdam, the 37-storey “**Tree House**” takes things even higher. The 140-metre-high residential and commercial building, designed by the London-based firm PLP Architecture, is set to open its doors in 2025. Even the 200,000-resident city of Eindhoven is offering its inhabitants “**The Dutch Mountains**,” an ecological architectural masterpiece. The U-shaped wood-hybrid building, designed by Studio Marco Vermeulen from Rotterdam, consists of two towers, 100 and 130 metres in height, which are connected at the base by a wooden structure, housing a winter garden and a lounge. Looking to the other side of the world – to Australia – construction began in Sydney in the fall of 2022 on a 40-story, 180-metre-high building designed by SHoP Architects from New York City (USA) for the software company **Atlassian**. Its completion is scheduled for 2026. And in Tokyo, people are already thinking decades ahead: Sumitomo Forestry and Nikken Sekkei, Japan’s largest architectural firm, are even planning a 350-metre-high wooden skyscraper for 2041 to mark the city’s 350th birthday “**W350**.”

SIMPLIFIED THINKING TO PLAN COMPLEX STRUCTURES

All of these high-rise buildings are based on sophisticated timber supporting structures - mostly made of cross-laminated timber (CLT), glulam or a combination of CLT with spruce or beech veneer laminated timber, also known as “Kerto” and “Baubuche” – supplemented by reinforced concrete stairwells and timber-concrete composite ceilings. Particularly challenging are the details of the joints and component transitions, such as ceiling/wall connections, prop/prop connections, or prop/beam connections, and the like. Modern timber construction encourages simple thinking to realise complex forms using optimal methods, thereby being material- and cost-efficient. The mentioned wooden high-rises provide extensive examples and will further advance timber high-rise construction worldwide.

Tip: Brochure from the Studiengemeinschaft Holzleimbau:

“Higher, faster, thought ahead: current timber engineering structures for the cities of tomorrow”

<https://tinyurl.com/2m6s4zub>

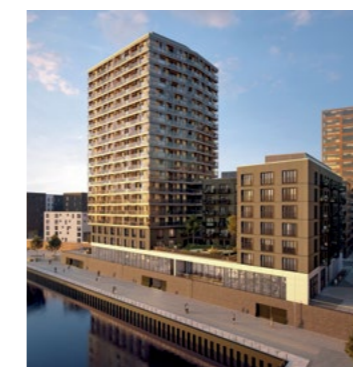


For a long time, the 85.40-metre-high “**Mjøstårnet**” (left image) in Brumunddal, Norway, was the tallest wooden high-rise in the world. In mid-2022, it was surpassed by the “**Ascent Tower**” in Milwaukee (USA) (photo right). The 25-story Ascent Tower held the global height record for wooden high-rises for a long time. Currently, it faces competition from Germany, the Netherlands, and Australia. In the long run, all of them will face competition from Japan with the “W350”.

The new Neckarbogen district of Heilbronn is home to Germany’s tallest timber-hybrid building to date at 34 m. For the opening of the 2019 Federal Horticultural Show, the ten-storey building called **Skaio** was completed.



The 65-metre-high residential tower “**Roots**” in Hamburg, Germany, was completed at the end of 2023. It has 20 floors, 16 of which are constructed using wood.



The next German record holder, the 98-metre-high “**WoHo**,” is set to be built in Berlin-Kreuzberg by 2026. The design of the tower, with its base composition, overhangs, and projections, as well as the clearly structured grid of wood, creates a dynamic building with the possibility of greening the façade.





On the outskirts of Lausanne (Switzerland), the 85 m high **Tilia Tower** is in the planning. The wood (hybrid) high-rise is part of an urban development project.



The 130 m high **Tree House** in Rotterdam (www.treehouserotterdam.nl), Netherlands, is scheduled for completion in 2025 and will be located between the central station and the main post office. The spectacular building will combine living, working, and recreational spaces.

With the residential high-rise „**Project Pi**” in Zug will be the tallest timber high-rise in Switzerland to date, rising 80 metres into the sky by 2024. The high-rise is divided into four segments, each slightly receding from top to bottom, giving the building a subtle tapering effect towards the base.



The sculptural U-shape of “**The Dutch Mountains**” is formed by two towers that are seamlessly connected at the base – one 130 m high, the other 100 m high. The elegant lines of the façade extend into a roof structure made of laminated wooden beams, which will be visible from the central interior.



The 84-metre-high wooden high-rise, known as “**Hoho**” (at left in the picture), in Seestadt Aspern near Vienna (Austria), consists of three wooden high-rises arranged in an L-shape. The tallest of the three stands at 57 metres and is positioned at the angle between the two shorter buildings, which are 40 metres in height.

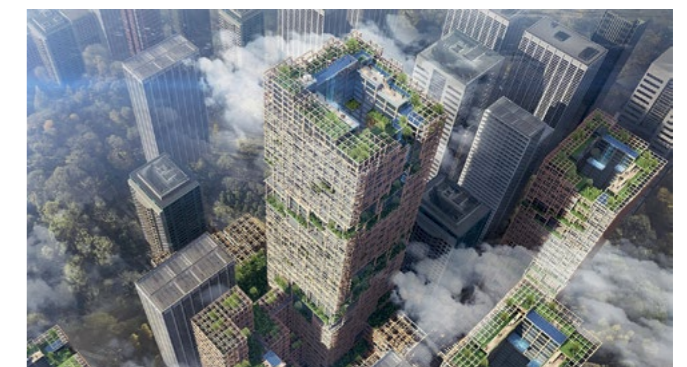


In Sydney, a 180-metre-high timber skyscraper is being built by software company **Atlassian** commissioned. The 40-storey building is scheduled for completion in 2026.

The 73-metre-high residential tower with 21 floors, named “**HAUT**,” stands in Amsterdam and has been the tallest wooden residential building in the Netherlands since March 2022.



Visions of the future in Japan: to mark the 350th anniversary of the city in 2041, a 350-metre-high wooden skyscraper, the “**W350**,” is to be built.



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