# CRADLE

## Hybrid Timber Building

Mixed construction methods as carbon storage



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#### Preface

## Why Hybrid Timber Construction?

Building with wood is not only a climate-friendly construction method in itself, but also a way of reducing the rising CO2 emissions in the atmosphere. Timber hybrid construction is the pragmatic cousin.

> ood can counteract man-made climate change. The amount of carbon dioxide (CO2) – or more precisely greenhouse gases in CO2 equivalents – in the atmosphere is more or

less linearly related to the rise in temperatures. Since the beginning of the industrial revolution around 1850 to 1900, they have risen significantly. Unlike the regenerating ozone layer, for example, these CO2eq will change on their own. If humanity wants to limit the rize in temperature to 1.5° C since around industrialization - the original goal of the Paris Climate Agreement – it is possible to say guite precisely how much CO2 the atmosphere should contain: around 800 gigatons. At the beginning of 2023, the remaining budget for this target was 250 gigatons, which would also be used up in six years based on current emissions. Now, permanently exceeding the 1.5° or 2° C limit would not be the downfall of humanity or the planet, as the limit was defined in Paris in 2015 in order to mitigate the well-known negative consequences and not exceed any of the so-called tipping points at which the climate system becomes unpredictable or the change irreversible. One of these tipping points relates directly to the construction industry and clearly illustrates the dilemma facing many of the measures being taken to combat climate change.

#### **Photosynthesis**

Wood utilization is one of the most important ways of removing CO2 from the atmosphere, because plants bind CO2 through photosynthesis. Chemically, it is water and carbon dioxide 6 H2O + 6 CO2 that become glucose and oxygen C6H12O6 + 6 O2. The glucoses combine to form cellulose. Wood consists of 50 percent of this cellulose. One cubic meter of wood binds around one ton of CO2. If the wood is burnt or rots, most of this

CO2 is released back into the carbon cycle. However, if it is used - and new trees are planted in sustainable forestry - the greenhouse gas is removed from the cycle. In order to achieve this quickly, fast-growing woods are advantageous and, to the delight of the construction industry, these softwoods also grow much more industrially compliant than hardwoods. Around 70 percent of the timber felled in Germany is softwood. And it is precisely these conifers that are most affected by the rise in temperature caused by climate change; the boreal coniferous forest – the largest of all – is one of the tipping points of climate change mentioned by climate researcher Hans Joachim Schellnhuber back in 2008. Nevertheless, Schellnhuber, Director Emeritus of the Potsdam Institute for Climate Impact Research (PIK), is one of the most important proponents of the idea of using timber construction as a carbon sink and propagates this with the 'Bauhaus of the Earth' (Bauhaus Earth). An average Finnish single-family house made of wood binds around 30 tonnes of carbon dioxide from the air - ideally, it does this for a few centuries while other trees grow for other houses. house made from wood binds.

#### Wood for the Soul

A second dilemma of timber construction is that it is both desired and feared by users. Wood has both biological and psychological advantages. First of all, with its natural surface and the warmth of the material, but also with the visual qualities of grain, aging and color, wood has an effect on the state of mind. Measurements in various workrooms showed that those with wooden furniture had the lowest electrical conductivity of the skin as an indicator of stress. In classrooms with solid wood, the heart rate variability of the pupils decreased when they entered. Numerous other studies show the positive influence of wood on

well-being and even on the assessment of competence and friendliness. The material therefore has psychological properties that go beyond the purely physical qualities of its appearance. In addition, quality wood is also beneficial in terms of building biology: wood creates a pleasant and healthy indoor climate. If the building material is stored and used dry, there is immediately no new building moisture and therefore no risk of mould, as long as the vapour barrier is properly installed. But with its ability to absorb and release moisture, open-pored wood becomes a natural air conditioning system. It also binds odours. On the other hand, however, we often hear about wood-based indoor air quality standards being exceeded by natural volatile organic compounds (NVOCs), which must be taken into account when selecting building materials for timber construction. Ventilation in the event of wood odours (terpenes) is the method of choice. Another building biology quality is that wood feels warm to the touch. This is because it does not conduct heat particularly well and therefore insulates heat better as a building material than steel, glass or concrete.

#### Wood burns

The main argument against wood is probably its flammability. Wood ignites at around 230° C, from 260° C wood burns even without an external heat source and from 400° C the wood gases ignite spontaneously. However, buildings today can be calculated for combustion: With increasing thickness, a wooden beam takes longer to burn through if the outer carbon layer does not prevent the core from burning through completely. If you make the beam thick enough, the outer layer can burn for 90 minutes while the core continues to bear weight. This means that some wooden beams can last longer than steel beams, which lose their strength at 500° C and above. In reinforced concrete, concrete can spall (due to expansion) and the steel reinforcement is then exposed; in prestressed concrete, the steel core reaches the critical temperature at 350°C. New wood-based materials offer further possibilities Heat treatment, which gives wood new properties, is also driving timber construction forward (Thermally Modified Timber, TMT). However, the development of cross laminated timber (CLT) and glued laminated timber (Glulam) currently appears to be having a revolutionary effect on timber construction: The properties can be controlled and it can be as strong as steel.

#### As well as: Hybrid Timber

Nevertheless, issues of statics and fire protection are the main reasons in favor of timber hybrid construction. Many building regulations continue to be critical of the use of wood in escape and rescue routes. Here, timber hybrid construction offers the opportunity to fulfill the requirements, calm users' fears and still use timber. Individual construction or building sections in reinforced concrete or steel construction also offer structural possibilities where timber construction (still) reaches its limits. The traditional timber frame construction method, the half-timbered structure, has been around for a long time with heights of 25-30 meters and up to seven stories, including attics. CLT in timber hybrid now goes beyond this. Hybrid construction also offers a solution for the parts in contact with the ground. Even in the Middle Ages, the plinth area or the entire ground floor of half-timbered buildings was made of stone to protect against rising damp and to create a stable substructure for the historic lightweight and system construction above. In the history of architecture, timber construction offered many advantages compared to stone construction, which can still be found - in a modified form - today. It was available in regions where stone was in short supply, offered a guick and comparatively inexpensive construction that easily spanned large spaces and roof trusses could be erected more or less on the spur of the moment in this particularly light and adaptable material. It was not always the case that timber was only used in its seasoned state, as the adaptability of the still moist and therefore 'intelligent' material was utilized for complex constructions. The self-supporting timber framework of the truss was then filled or boarded with any material. In the case of roof trusses, this tradition has survived through modern times to the present day. Contemporary timber hybrid construction nevertheless has to deal with new issues, such as the behavior of the very different building materials of timber and concrete when external influences such as humidity or temperature change. This first volume of the CRADLE Books shows the problems, but even more so the solutions and advantages of modern timber hybrid construction in 50 examples of a wide variety of building types. 50 buildings that also aim to contribute to climate-positive construction in many other ways: sometimes through technical building equipment, sometimes through engineering, flexibility, local building materials or craftsmanship. Most importantly always through the art of building, because a lasting pleasure in the respective architecture and the resulting will to preserve it is one of the most sustainable characteristics of buildings.

> Chris van Uffelen Editor-in-Chief CRADLE Magazine



Article from magazine CRADLE #4: Urban hybrid timber construction

## **More Wood** for the city

It's a question of will, because for Tom Kaden there is no such thing as an apolitical house.

When the residential building E3 by Kaden + Klingbeil Architekten at Esmarchstrasse 3 in Berlin was completed in 2008, this closure of a building gap was exotic: Who needs a 25-meterhigh seven-story timber building in an European metropolis? Today, nobody questions this pioneering achievement and Tom Kaden has been consistently developing the principle of large-volume hybrid timber buildings ever since.

#### Tom Kaden

Master woodworker, \* 1961

Tom Kaden initially studied applied arts in Schneeberg and graduated as a designer from the Weißensee School of Art in 1991. In 1995, he realized his first timber house in all work phases. From 1996 onwards, he was the owner and co-owner of various architectural offices – since 2021 of the current office Kaden+ GmbH. In 2004, he began to work intensively on inner-city multi-story timber constructions, building group projects and participatory construction, as well as on the use of public land in teameleven. Since 2014, he has held a lectureship at the Department of Wood Technology at the Eberswalde University for Sustainable Development, and from 2017 a professorship for architecture and timber construction at the IAT - Institute for Architectural Technology at Graz University of Technology.



ood is considered to be one of the best ways of reducing CO2 levels in the atmosphere. The building material stores the climate-damaging gas as it grows naturally: Up to one ton of CO2 is bound in one cubic meter of wood and thus removed from the atmosphere. However, in 2008, this realization was still hardly in the public eye. As a result, even experts wondered why wood should be used in the city. The building regulations did not provide for timber houses of this size, nor was it cheaper, and the natural building material was not visible on the façades. So why? At best because of the healthy living conditions, the atmosphere, and people love for the natural product. The advantages of prefabrication and quick implementation were of course also known

> At first glance, the E3 in Berlin does not look like a timber construction. However, the concrete access from the side is a clear indication.





E3, Berlin, 2008: The E3 by Kaden Klingbeil Architekten was the breakthrough of hybrid timber construction in the metropolitan center of the European city. With a 22-meter-high timber construction and seven residential floors, the building was not actually possible within the framework of Berlin's building regulations. Fire protection issues therefore had top priority. Only the short, smoke-free escape routes – through the external staircase - and the maximization of the fire resistance of the load-bearing and stiffening timber components - through seamless fire-resistant cladding with mineral wool (outside) and gypsum fiber boards (inside) - made it possible to implement the timber frame construction method with a special permit. The green staircase and lateral firewalls are made of reinforced concrete, the two service cores of in-situ concrete. The individual stories are separated by timberconcrete composite ceilings with wooden elements made of 16-centimeter-thick glulam. The eight residential units have a combined living space of 987 square meters.

In the meantime, the concrete stairwell has also been greened.



The wooden skeleton is bolted together so that it can be dismantled again if necessary. The walls are installed as prefabricated elements.

from the single-family house. But other reservations dominated: in terms of fire protection, maintenance, statics, style.

"However, a lot has changed in the meantime," explains Tom Kaden, the architect of E3, "politicians, authorities and residents are more open to timber construction." The climate change movement, which promotes building with wood, is also responsible for these changes. Politically, however, things are moving much more slowly. Although the model building code, which will be amended in 2022, is much more open to timber construction, it must be adapted as a minimum standard in the individual state building codes. "Austria and Switzerland in particular are further ahead," says Kaden. Nevertheless, Kaden now builds many residential buildings – mainly in Berlin, but also in Hamburg, Munich, Oberursel, and Heilbronn – almost always using hybrid construction methods. He also uses this hybrid technique for other projects, as Kaden+, as his office is known, now also plans universities, daycare centers, offices, and sports facilities. Most recent projects include the Globe Theater in Coburg, a school extension in Leipzig. and an extension to the University of Witten/Herdecke.

Hybrid timber buildings are an ideal way of increasing the proportion of timber for sustainability reasons without having to give up the advantages of other



building materials. Wood is therefore a material rather than an aesthetic choice. "But every design decision also has political relevance." For example, by removing the reinforced concrete staircase from the enclosed structure as a smoke-free escape route in E3 and many later residential buildings, Kaden made it easier for the building inspectorate to approve the design and the finished building. After all, fire protection was one of the main reasons why wooden façades were not used in high-rise residential buildings for a long time.

Nevertheless, there is still a lot to do, as timber buildings are still generally only three to four stories high. "18 percent of completed buildings in Germany are made of wood," says Kaden. "This includes many single-family homes. If you relate that to multi-story



Skaio, Heilbronn, 2019: This residential building with commercial units is Germany's first high-rise building in timber construction. It comprises 60 rental apartments of 40 to 70 square meters, which are planned to be interconnected. Around half are publicly subsidized. There are also four shared flats for people in need and a roof terrace, a large kitchen, and a launderette for communal use, which serve as a meeting point. With ten floors, including stories whose floors are higher than 22 meters, the Skaio is considered a high-rise building. For this reason, the high-rise building regulations had to be adhered to. Reinforced concrete is only used in the base story and the access core, and steel is used for the ceiling beams. The ceilings and non-load-bearing walls are made of cross-laminated timber, the columns of glulam. The entire planning provides for subsequent disassembly and recycling.

PE16W, München, 2020: On the south-eastern edge of the Prinz-Eugen-Park urban quarter, Kaden + Lager built 87 residential units with a living space of 5,736 square meters, divided into three staggered structures in solid wood and timber hybrid construction, as part of the ecological model estate. The PE16W is part of the largest contiguous timber housing estate in Germany with 566 apartments - 452 of which are rental apartments – on around 10 of the 30 hectares of a former barracks. Other buildings are the work of ARGE agmm architekten + stadtplaner and Hable Architekten, ARGE ArchitekturWerkstatt Vallentin with Johannes Kaufmann Architektur, ARGE H2R Architekten with plan z architekten, Dressler Mayerhofer Rössler Architekten und Stadtplaner, Nest Ecoarchitektur, and Zwischenräume Architekten und Stadtplaner. The City of Munich set up a funding program for timber construction.





#### Witten/Herdecke University extension, 2021:

Kaden + Lager designed the new building for the private Witten-Herdecke University as a hybrid timber and timber skeleton construction. With its large columns and beams, the spruce timber skeleton clearly characterizes the interior. In this skeleton, the rooms can be dimensioned very differently so that the diverse room program can be easily distributed. Including the façade made of untreated larch wood, a total of around 10,000 timber construction elements were used.

#### Timber construction in the city is an expression of a socially determined necessity.

Tom Kaden

residential construction, the figure is perhaps two percent." In his opinion, this proportion needs to increase, especially as wood is ideal for prefabrication and serial construction and can therefore counteract the pressure to create new living space quickly. "We don't have to use as much wood as possible," says the Professor of Architecture and Timber Construction at Graz University of Technology, "but only as much as is structurally and physically necessary." A pragmatic timber construction incorporates other materials where they make sense and may even benefit the wood. Even medieval half-timbered buildings often had a first floor or plinth made of stone because these parts were in contact with the ground and it offered structural advantages. Built in 1529, the Knochenhaueramtshaus (reconstructed in 1989) in Hildesheim, the tallest half-timbered house in Germany, towers one meter above the E3 with its ridge. With the Skaio in Heilbronn, Kaden then erected the first high-rise building in timber construction in Germany in 2021: 34 meters and therefore eight meters higher than the guild house of the Hildesheim butchers, whose con-

struction technique was of course completely different and would no longer be conceivable today. The Skaio was a flagship project as part of the Neckarbogen model district and the 2019 Federal Garden Show – but Tom Kaden sees the future more in four- to seven-story residential buildings made of wood. Pilot projects such as the Skaio, but also quality across the board, are important because every building is always a statement by the designer. "Architecture is a political channel – there is no such thing as an apolitical building, and we are therefore jointly responsible for the socio-spatial and ecological sustainability of architecture."

> www.kadenplus.de Text: Chris van Uffelen Fotos: Bernd Borchardt (8, 10, 12), architekturfoto.berlin (Porträt 9, 13), Johannes Buldmann (11)

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Thivya Athmanathan and Roland Bechmann (Werner Sobek AG)

## Hybrid timber from an engineering viewpoint

Gray and practical from above, chic and elegant from below. Hybrid timber construction is more in demand than ever. In recent years, it has become a buzzword for sustainability and the innovative use of wood and concrete.

For architects, the hybrid timber construction method offers new possibilities for integrating the homely, warm construction material wood into the design of taller buildings without having to compromise on functionality. From a structural engineering perspective, the composite material also represents a versatile resource with great potential. In particular, the large reduction in weight and mass compared to concrete structures, as well as a high degree of prefabrication, make this promising from the client's point of view, which is why hybrid timber construction is proposed by the client himself in many projects. Sounds good at first, right? So why do we often stick with "conventional" construction methods when hybrid timber is the answer?

#### **Tried and Tested**

Let us first take a step back and look at what hybrid timber actually is. After all, what has been praised in recent years as an innovative new material is actually a tried and tested construction method with a long history. First of all, the term "hybrid timber" (just like the term "timber-concrete composite construction", which is used synonymously here) simply refers to mixed constructions that, for example, have a reinforcing staircase core made of concrete while the remaining components are planned in timber. Alternatively, they can also be steel structures with timber infills. The term can also refer to composite materials in individual components. For example, timber columns can be reinforced with steel from the inside. Another combination that has been used more frequently in recent years is ceiling systems made of wood and concrete. Hybrid timber construction has therefore been around for some time. Why is it only now being rediscovered?

#### Reassessed

The reasons are simple: scarcity of resources coinciding with a growing population, high emissions in the

Wood and concrete can be constructively combined in different ways.





The new fire station in Karlsdorf-Neuthard was completed in 2023 by the architects Deubzer König + Rimmel Architekten. Werner Sobek was responsible for the structural design of this project. The building with its trapezoidal base is characterized by its particularly high earthquake resistance, which it owes to the timber hybrid construction method. The cross-laminated timber panel can transfer the shear forces of an earthquake to the reinforced concrete cores, while the wall-like beams made of cross-laminated timber ensure that the high ceiling loads are secured.

construction sector, and the urgent need to minimize our consumption of raw materials and make them recyclable. Due to its versatility and properties as a renewable raw material and as a CO2 binder, as well as its relatively low weight, wood is an all-rounder for sustainable use and should therefore not be missing from a structural engineer's repertoire. However, in order to properly utilize the potential of wood as a sustainable material and to enable its use in the construction of tall buildings such as schools and office buildings, a number of factors must be taken into account.

#### **Complex Planning and Standards**

Wood is a material that makes it harder to work with empirical values or "rules of thumb" than concrete. for example. Details and connections must therefore be carefully planned and coordinated at an early stage. Subsequent changes are difficult to implement. Even if (almost) anything can be built from wood these days (and many impressive example buildings prove this), the overriding goal of sustainable construction should not be jeopardized by an unfavorable choice of material. A load-bearing structure that is regular in base and elevation is the main prerequisite for an economical and material-efficient use of the limited resource wood. But it is not only from a structural point of view that sensible framework conditions must be observed. Sound insulation in particular is a vital criterion to be taken into account when selecting the material. Because sustainability only works as a whole. A particularly lightweight load-bearing structure at the expense of sound insulation has to be compensated later with fills and thus misses the target of a load-bearing structure designed to be sustainable in its entirety. The same applies to a material-saving beam system



A concrete core with a timber construction attached to the side.

without a concept for building services cable routing in place. Or for a structure with a high load-bearing capacity that can neither be dismantled by type of material nor reused. It is therefore clear that hybrid timer can only offer a particularly sustainable solution if all specialist planning disciplines cooperate. The combination of wood with concrete as a building material, which can be used to control both the required thermal and acoustic mass, has some enormous advantages when used correctly. So is this already the perfect, sustainable construction method?

Unfortunately, an all-encompassing solution that takes all interests equally well into account is not yet in sight (and probably never will be). Due to the complex interplay of many disciplines, some of which also pursue opposing interests (keyword: mass reduction vs. noise protection, etc.), there are a multitude of solution approaches that need to be evaluated on a project-specific basis. This can also be seen in the many manufacturer-specific product solutions and construction methods. The wood-concrete composite method for ceiling systems alone has at least 15 different combinations and design variations of the materials wood and concrete, each and every one of which has its own advantages and disadvantages.

Close cooperation with manufacturers of fasteners as well as with suppliers etc. is therefore essential in order to remain at the forefront of technology – especially against the background of constantly changing approval regulations. This is because timber-concrete composite construction is not yet part of standardization and therefore often requires individual approvals from the manufacturers. Particularly when it comes to the fire safety of taller buildings, there are a number of hurdles for a verifiable approval. At this point in the planning process, some clients get cold feet. Public clients in particular are concerned about possible approvals in individual cases, which can lead to time-consuming processes. Is there any improvement in sight?

Definitely yes! On the one hand, there are already pre-standards set in place, which can serve as a basis for the design of timber-concrete composite components. On the other hand, it is foreseeable that the upcoming timber construction standard will include the design of timber-concrete composite elements. The review process for the draft of the Eurocode 5 is expected to be completed by the end of 2024 and must then be incorporated into the future timber construction standard. As far as fire safety is concerned, buildings will soon be able to be designed with a fire resistance for a duration of 120 minutes without any hurdles. In addition to the actual normative regulations, the hybrid timber construction method is also well received by inspectors. The particularly constructive cooperation in finding verification concepts that work under approval law simplifies the process enormously. Due to the spreading popularity of hybrid timber construction, the number of inquiries about HBV systems has also increased significantly; it is now part of the usual variant studies in the initial discourse between planners and clients on the load-bearing system.

#### **Sustainable and Economical**

In addition to the suitability for use in the load-bearing structure, the cost-effectiveness and procurement of timber is also being discussed. The great advantage of hybrid timber construction is the high degree of prefabrication and with it the acceleration of the construction process. In combination with the low weight and better transportability, entire buildings can be erected in just a few weeks, thus significantly reducing equipment, construction site, and personnel costs. However, increased demand for construction timber also inevitably leads to the question of how to procure it sustainably. In contrast to concrete, wood is a naturally growing raw material that has a limited supply. However, in order not to lose sight of the aspect of sustainability, the type of stock must also be taken into account. Ideally, the construction timber used should be sourced in Germany and belong to the natural stocks







#### Thivya Athmanathan and Roland Bechmann

Hybrid timber construction specialists at Werner Sobek, \* 1995 and 1973

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Thivya Athamanthan was born in Neuss and studied civil engineering at the RWTH Aachen. Since 2019 she has been working as a project manager at Werner Sobek, where her focus is on hybrid timber constructions as well as the areas of reinforced concrete and masonry.

Roland Bechmann joined the Werner Sobek AG after studying civil engineering at the University of Hanover – initially as a project manager and since 2016 as a board member and partner. He is also an honorary board member of CTBUH Germany e.V. and an ambassador for the Koalition für Holzbau (KfH).

The Werner Sobek AG was founded in 1992 by Werner Sobek (\* 1953). The internationally active office in Stuttgart is working in engineering and architecture with a focus on sustainable construction. Werner Sobek is one of the initiators of the Deutsche Gesellschaft für Nachhaltiges Bauen (DGNB). - but this is quickly reflected in the price and availability. So what means can be used to achieve a sustainable yet economical availability of construction timber?

In many state-of-the-art scenarios, dismantled woodbased materials are often recycled for energy at the end of their use. Wood that is already in use represents an especially great resource potential and can either be recycled or at least reused in other products (downcycling). However, this principle of the wood cascade only works if it can be separated by type and dismantled, which is currently only achieved to a limited extent, particularly in the case of wood-concrete composite structures. But here too, intensive work is being done to develop composite solutions without monolithic grouting joints. For example, separating layers can be installed between wood and concrete. In this way, the hybrid construction method can also remain in competition with pure timber construction from a recycling point of view.

#### Outlook

In summary, it can be said that hybrid timber offers many opportunities, but also brings with it various challenges. The opportunities can be seen very clearly in the following projects; they show the extent to which hybrid timber construction has already established itself. As far as the challenges are concerned, these will certainly be mastered step by step in the coming years, both from a structural engineering perspective and from the perspective of other disciplines. However, it is important to realize that hybrid timber construction cannot present a solution for all problems. Rather, it is a valuable addition to existing types of construction. It is a supplement that must be used responsibly and appropriately by all specialist planners – but one that opens up many new possibilities in terms of saving resources and sustainability.

> Text: Thivya Athmanathan and Roland Bechmann www.linkedin.com/company/werner-sobek/ Portrait photos: Janine Kyofsky, Backnang (17) Photo: Holger Hinz / Werner Sobek (15) Grafics: Werner Sobek AG www.wernersobek.com



Interview from CRADLE Magazine #3 with Christian Gaus

## Wood vs. Fire

Timber construction is set to play an important role in climate protection in the future. But what about the risk of fire?

In June 2023, German Federal Building Minister Klara Geywitz and Federal Agriculture Minister Cem Özdemir presented a strategy for timber construction. Wood removes CO2 from the atmosphere, is regionally available, durable, lightweight and – when used appropriately – can also be reused. CRADLE interviewed Christian Gaus, the architect of the wooden fire station in Tübingen-Lustnau.

CRADLE: Mr. Gaus, you have built a wonderful station for the volunteer fire department in 2022. In line with the political will, it is made of wood from sustainable, regional forestry. But wood does burn! Is that an ironic statement?

**Christian Gaus:** Quite the opposite. After all, the fire department's job is not just to put out fires when they are already burning. Fire prevention and education are just as much a part of it, and there are few prejudices as stubborn as the one that wooden buildings are dangerous in a fire. Yes, wood burns, but it burns predictably and if some steel beams give way due to high heat, some thick wooden beams in flames will

View of the fire station in Tübingen-Lustnau from the village with the administration wing on the left and the retention area behind it.

continue to support them. Steel loses its strength at 300 °C, wood ignites at 280-340 °C. It takes a while for these beams to burn through. This is because the wood makes use of its positive property of charring. The charring on the surface protects the layer of wood underneath and thus slows down the burning rate enormously.

#### Like in a fireplace or at a barbecue?

Exactly, everyone knows the effect that the logs are not so easy to ignite and it takes quite a while for them to burn through. Only in timber construction there are great fears, not only among users, but also among administrators and legislators. The laws, regulations and guidelines on fire protection in timber construction were and still are overly cautious in some cases; presumably because timber was seen as replaceable. Now it is to be used as a CO2 sink – Tübingen's mayor Boris Palmer wants to make timber construction mandatory in the city by 2030 – and fire protection must be freed from nonsensical regulations. But wood is, of course, a combustible building material.

#### How is fire protection regulated?

Firstly, its three main tasks are to protect against fire and smoke, to rescue people and animals, and to enable effective extinguishing work. This is regulated in the first instance by the federal model building regulations (MBO) in the state building regulations based on them. There are five building classes (GK), which are differentiated according to floor area and, above all, according to the construction heights of 7, 13 and 22 meters. This corresponds to fire department ladder lengths. Depending on the building class, there are then different requirements for the duration in minutes during which a building component must retain its function in the event of a standard fire: fire resistance classes F30 to F240. The requirements vary depending on the building component - a stairwell should be able to withstand fire for significantly longer than a nonload-bearing wall. However, since 2002, the MBO has



Floor plan with vehicle rear exit direction at the bottom and the drive into the hall at the top.

also allowed load-bearing and bracing parts made of combustible building materials in GK4, including wood, if they have a cladding made of non-combustible building materials. The new Model Timber Construction Guideline (M-HolzBauRL) from 2021 now also allows load-bearing, bracing or room-enclosing components in GK4 and 5, which according to the MBO must still be highly fire-retardant or fire-resistant, to be made of solid wood or in timber frame and timber panel construction if they have proof of F60 (GK4) or F90 (GK5). External wall cladding made of wood and wood-based materials is now also possible.

#### That sounds extremely complicated.

And it is. This is why the proportion of timber construction in detached and semi-detached houses, i.e. those in GK1 and 2, is already at a quarter, while – according to the Federal Ministry of Agriculture – it is still below five percent in multi-story residential construction. This must become easier. This is why hybrid timber construction is the most practicable solution for the higher building classes. This is also the case with our fire station: as much as possible is made of wood, but the stairwell and elevator shaft are made of concrete. It is important to choose the right type of construction.

### Everything else is made from regional wood?

For the most part. It is FSC-certified wood from the Black Forest and the Allgäu. All ceilings are made of untreated glulam. The floors in the training and youth rooms are covered with industrial oak strip parquet. The windows have wooden frames made of spruce, the fire protection windows are made of oak, the ventilated exterior façades are made of silver fir slats of dif-



#### Christian Gaus

#### Fireproof architect, \* 1973

Christian Gaus studied architecture in Dessau until 1998 and founded his own office in Göppingen in 2000. This was followed by a design laboratory in Rotterdam and further branches in Stuttgart and Kiel in 2023. Since 2002, fire stations have been a building task that has shaped the work of the evergrowing office to this day. As early as 2005, Gaus was involved in the construction of a fire station in Schwäbisch Gmünd-Rehnenhof in an all-timber ensemble. But he also repeatedly uses wood in other construction projects.

ferent widths and depths. Structurally, the two-story building consists of a timber frame structure with beams and columns made of glulam as well as beech beams and columns inside the building. Even the

#### Glossary

A comprehensive glossary for the entire book can be found on page 228.

- Glulam
  Timbers glued in the same grain direction.
- Fish-belly Beam
  A truss girder that is straight at the top but has a convex bottom chord.
- > Fire resistance classes (F)

Regulates the fire resistance of components in minutes: F30, F60, F90, F120, F240. In addition, the German DIN 4102 and the European DIN EN 13501 **building material classes** also take into account flammability: from *A non-combustible* and not contributing to fire to *F highly flammable*. Classifications for smoke development *s1 low* to *s3 high* must also be taken into account.

> Building classes (GK)

According to German model building regulations (MBO) GK1: free-standing buildings, height up to 7 meters, no more than two units of use, up to 400 m<sup>2</sup> in total; GK2: also not free-standing; GK3: also with more units of use; GK4: also up to 13 meters, no unit of use more than 400 m<sup>2</sup>; GK5: all others, height up to 22 meters; special buildings such as high-rise buildings or places of assembly.

Timber Hybrid Construction
 Combines (little) concrete with wood

> Regional Construction Ordinances

The LBOs are based on the model building regulations MBO and have very different views, particularly with regard to fire protection. Saxony, Berlin, Bavaria, and Baden-Württemberg are open to timber construction. The new administrative regulation Technical Building Regulations (VwV TB) Baden-Württemberg from December 2022 makes even more possible here, e. g. insulation made of wood fiber, straw or hemp, and fire protection cladding made of clay. façade insulation uses wood fibers. The roof of the seven meter high and 15-meter-deep vehicle hall is supported by large fish-belly beams made of glulam. Due to the additional static requirements, a burn-off time far in excess of the prescribed 30 minutes can be expected; by then, the vehicles would have long been outside.

#### The vehicle hall has doors on both sides?

This is one of the typical solutions for such buildings and has the advantage that the vehicles do not have to maneuver, but can drive through. This reduces the noise level for the neighborhood and creates two courtyard situations at the same time: a representative one facing the town and a more private one facing the adjacent meadow. We were also able to use this as a retention area. On the local side, the water flows at a

Timber hybrid construction of the staircase in the administration wing: The stairs are made of concrete, while walls, ceilings, and pillars are made of timber.



low-lying crossing in front of the fire station into a tunnel that leads under the fire station to the meadow.

### So another aspect of environmentally friendly construction; are there others?

The administration wing achieves KfW40 and almost the passive house standard, has a photovoltaic system for directly usable electricity, and solar thermal panels for hot water. The biggest gain, however, lies in the timber construction: Instead of producing 85 tons of CO2 like a comparable concrete building, only six tons were produced here. The saving is therefore much better than the minimum 50 percent that Cem Özdemir mentioned. This is because we are removing around 380 tons of CO2 from the atmosphere, which is bound in the wood, i. e. in the building.

www.gaus-architekten.de Text: Chris van Uffelen Photos: Oliver Rieger

Graphically adapted article from the magazine CRADLE 3, released 2023.

Rear exit for the fire engines and view into the hall with the large wooden beams.

## Sarah Reißner (Züblin Timber) Hybrid Timber Implementation

This text looks at hybrid timber construction from a practical construction perspective. Combined with single-variety deconstruction, new approaches are developed on how to reuse timber formwork from large construction sites in the future.

#### **Circular Construction in Practice**

Circular construction – one of the most important topics in today's future-oriented and sustainably executed construction projects. Why is the topic of the circular economy so important? This question can be answered simply by looking at the Earth Overshoot Day. The Overshoot Day is the exact date, divided by country, when all available resources for the year have been used up. According to the latest statistics from the National Footprint and Biocapacity Account, we already used up the entire amount of usable resources for the year 2024 in Germany on May 2nd. This leads to the conclusion that resources must be used more sensibly and, above all, more sparingly.

The construction sector is a major consumer of these resources. This is why Strabag SE, and therefore Züblin Timber as well, has dedicated itself to the topic of efficient resource use with its Work on Progress guideline. This is achieved by using state-of-the-art technologies to save, conserve, and recycle raw materials and components. The entire life cycle is taken into account for every constructed building and the costs for dismantling, disposal, and recycling are already taken into account in the planning stage. A life cycle assessment of a construction project allows further potential to be identified and utilized in order to minimize environmental impact.

#### Milestone: Skaio in Heilbronn

With the construction project Skaio in Heilbronn Züblin Timber set a major milestone in terms of circular construction back in 2018. Not only was the construction project the first hybrid timber high-rise building in Germany, but it was also built using a cradle-to-cradle compatible construction method and in addition has received a DGNB Gold & Diamond certificate. The 34- meter hybrid timber high-rise was built as part of the



Layered construction of the Skaio ceiling using various materials.

Neckarbogen city exhibition in Heilbronn and consists of a reinforced concrete and hybrid timber construction, which was predominantly built using timber. Together with the former architectural firm Kaden+Lager GmbH in Berlin (today: Kaden GmbH und Lagerschwertfeger GmbH), great attention was paid to the deconstructability and recyclability of the building.

Roughly broken down, the load-bearing components of the high-rise building in the basement, first floor, and second floor are made of in-situ concrete. The load-bearing structure of the other upper floors (the 2nd to 9th floor) consists of a timber-steel hybrid construction based on the principle of skeleton construction with glulam supports. Non-load-bearing external walls were made of Leno-cross-laminated timber with



View of a floor of the Skaio with the Leno-crosslaminated timber ceiling and glulam supports.

an external insulation layer. The rear-ventilated exterior wall cladding was made of metal elements. On the lower floors, the façade consists largely of a mullion-transom construction with glazing.

In terms of separability, the used reinforced concrete in particular can be dismantled at the end of its usage period and divided into concrete and steel accordingly. The concrete recovered from this is crushed again into different grain sizes, washed in a wet classification plant and can be used again as concrete aggregate in its further life cycle. The reinforcing steel can be completely recycled, which is already a standard procedure these days, allowing steel companies to work with recycled steel. The assembled metal façade elements were attached to the corresponding exterior timber walls using a substructure. These aluminum panels were invisibly suspended from concealed welded aluminum bolts. This approach means that the material can be easily dismantled later and 100% recycled. Another important aspect in terms of deconstructability are the corresponding story ceilings, which were designed in solid wood. The floor structure of the ceilings was made up of alternating layers of honeycomb-bonded fill, a Fermacell board as a smoke-proofing layer, impact sound insulation, and dry heated screed and is therefore completely dry and reversible. This unbound layering means that the materials can be dismantled separately.

With regard to the respective connections, all components were bolted together in the construction project, meaning that the building can be completely disman-