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Advancing Timber for the Future Built Environment

NEW DIMENSIONS – TIMBER PROJECTS AND CONNECTIONS

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ABSTRACT: Timber construction is entering new dimensions – and connections are the decisive factor. The performance of various connection types is illustradet through three recent WIEHAG projects:

Architectural construction: The World of Volvo in Gothenburg, featuring tree-like columns and hidden steelplate timber connections with high-strength screws.
Industrial construction: EDEKA's 110,000 m² warehouse in Marktredwitz, using long-span glulam beams and steel-dowel connections with internal steel plates.
Multi-storey timber office construction: A 14,500 m² office building in Leipzig, employing system connectors for clean, concealed joints.

KEYWORDS: timber connections, (high-strengh fully threaded screws), dowel connections, system connectors

1 – INTRODUCTION

Over the past several years, WIEHAG has delivered a wide range of projects across **Architectural**, **Industrial**, and **Multi-Storey Timber** construction. In each case, the choice of connection technology must respond to project-specific requirements – balancing appearance, functionality, stiffness, and repeatability.

This paper presents three recent WIEHAG projects and outlines the connection types used in each. The complete load-bearing timber structures were realized between 2022 and 2024, with all timber elements assembled on site by WIEHAG. Sturctural analysis, shop planning, production, and logistics were also handeld in-house by WIEHAG.

Figure 2 Edeka, Marktredwitz

Figure 1 World of Volvo, Gothenburg

Figure 3 Bundesliga football club, Leipzig

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2 – PROJECTS IN ARCHITECTURAL, INDUSTRIAL AND MULTI-STOREY OFFICE BUILDINGS

2.1 ARCHITECTURAL CONSTRUCTION – WORLD OF VOLVO

The World of Volvo in Gothenburg is an experience center for Volvo Group and Volvo Cars, reflecting Scandinavian landscapes and traditions. After winning a design competition in 2018, Henning Larsen was chosen as the architect. WIEHAG joined the team to address the structural challenge of stabilizing the timber structure. Vertical loads are transferred through façade and tree-like columns, originally intended to be supported by roof beams. The main hall, surrounded by a park and topped with an organic Pavilion, creates complex loading conditions for the structure.

Although the beam layout in the main hall follows a certain regularity (see Figure 5), load distribution is far from uniform. WIEHAG explored multiple options for splicing locations, the placement of pinned versus moment-resisting connections, and the continuity of beam runs. Ultimately, it was determined that all beam junctions should be moment-resisting, with rigid steel star nodes located at critical deflection zones. These star nodes were key to maintaining structural stiffness (see Figure 6).

The tree trunk columns themselves contribute lateral stability, functioning similarly to large vertical tubes. Their cylindrical geometry—combined with a tension ring at the top—further enhances structural performance. At the base, each column is pinned using WIEHAG's factory-fitted concealed connectors, ensuring clean load transfer and architectural precision.

Designing a complex, multi-level organic structure in CAD presents unique challenges. As illustrated in Figure 4, a fixed reference is essential—WIEHAG defined this through the top edge of the roof beams in the main hall and the base points of the columns. Two WIEHAG engineers dedicated over a year to completing the 3D model, shop drawings, and installation documentation. In total, nearly 9,000 production drawings were generated for the timber structure.

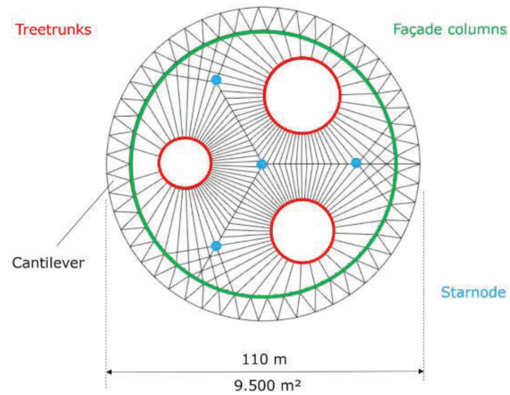

Figure 4 Structural concept

The 3D modelling process combined **Cadwork** and parametric design tools. Coordination across trades was managed via the cloud-based BIM platform **Trimble Connect**, which was essential for handling intricate interface conditions across different disciplines. The structure uses glulam fabricated from **PEFC-certified European spruce**, with strength grades up to **GL30c**. Due to the large cross-sections, most glulam elements were **block-glued**. Preassembly of steel components at the factory was critical—not only to ensure high-quality and visually clean connections, but also to streamline installation and improve on-site safety. The glulam elements were transported 1,400 km from WIEHAG's factory in Altheim, Austria, to Gothenburg. The CLT components were sourced from Stora Enso's facility in Grums, Sweden, located just 220 km from site. Although some glulam beams reached lengths of up to 33 metres, transport was not a major obstacle—the final access route from the motorway to the site provided sufficient clearance and turning radius. WIEHAG managed the permitting process, escort vehicles, and coordinated night-time deliveries to minimise disruption and ensure safe, efficient delivery of these long-span elements.

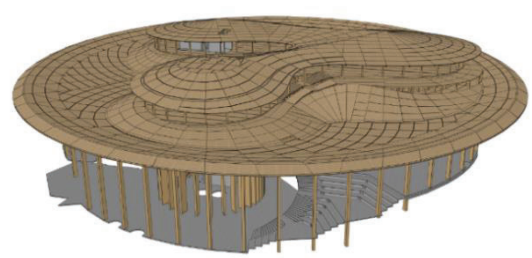

Figure 5 World of Volvo plan view - beam layout of main hall

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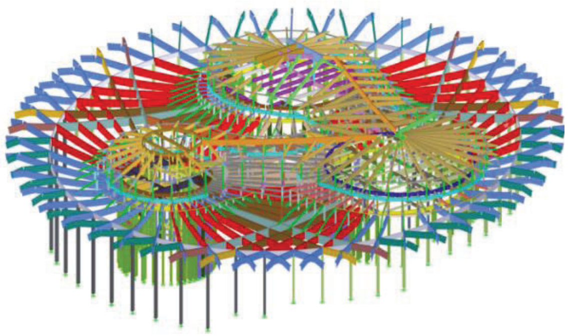

Figure 6 Total structural concept

2.2 IINDUSTRIAL BUILDING – EDEKA MARKTREDWITZ

EDEKA is investing €600 million in its logistics infrastructure, including a new central warehouse in Marktredwitz, northern Bavaria, to support automated online retail. The 461,700 m² site will house up to 27,000 products by 2030. The facility spans over 110,000 m² and is built in three phases. WIEHAG Timber Construction supplied 15,000 m³ of glulam in one year and provided structural analysis, engineering design, and timber-specific expertise for optimization before execution.

The glulam roof beams span between **28 and 40 metres**, designed to accommodate a **snow load of 2.50 kN/m² (Snow Load Zone 3)**. As a result, many of the beams were large cross-section members, often block-glued. The largest elements measured **420 mm wide by 3,200 mm high,** with unit weights of up to **18 tonnes**.

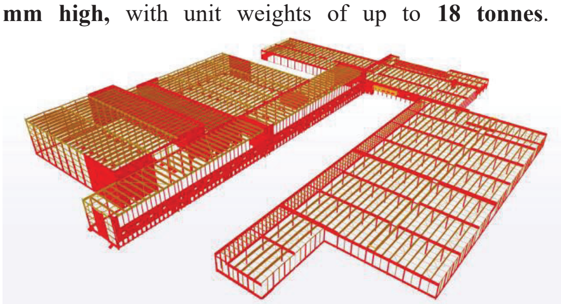

Figure 7 EDEKA, digital twin by WIEHAG

Due to the project's complexity and tight timeline, precise coordination across disciplines was essential. **Building Information Modeling (BIM)** played a central role. WIEHAG and solid construction engineer PGS exchanged structural models, with interface components evaluated using elastic spring elements to ensure accurate load transfer down to the subsoil.

WIEHAG developed a comprehensive **3D model – effectively a digital twin – of the timber structure**, capturing all member positions, cross-sections, connection details, and interfaces with the concrete works (see Figure 7). This model was integrated and reviewed by planner PBB, allowing for real-time validation of positioning, clash detection, and identification of missing elements. This approach eliminated the need for time-consuming and error-prone 2D plan coordination across trades.

The structural review and approval process was also conducted digitally, using the 3D model to streamline coordination across all trades. This saved several weeks of inspection time and significantly improved accuracy. As a result – with a few minor exceptions – expensive reworking on site due to interface issues was avoided.

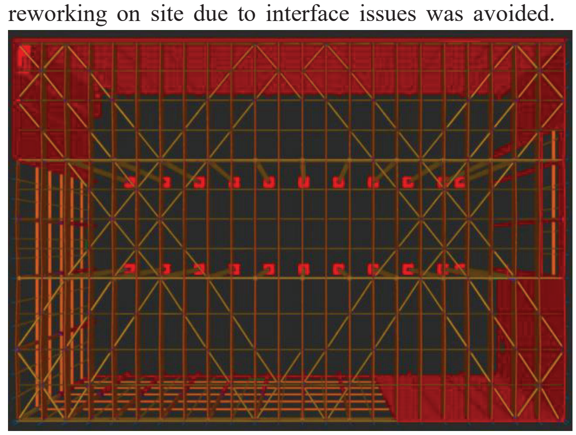

Figure 8 groundview bracing high warehouse 36 m

2.3 MULTI-STOREY BULDINGS – NEW OFFICE OF A BUNDESLIGA CLUB IN LEIPZIG

A new office building for a renowned German Bundesliga football club is currently under construction in Leipzig, with a total building area of **14,500 m²**. The design follows a campus-style concept that combines open-plan workspaces with communal areas intended to foster collaboration and well-being. As project architect **Christoph Wunderlich**, *Authorised Signatory and Head of SHA's Berlin office,* explains:

"The design is based on the idea of a campus that includes both open office landscapes and communal areas where employees can meet – spaces that improve well-being and where the exchange of knowledge, innovation and creativity can flourish."

Once completed in late 2025, the building will provide workspaces for **250 employees** across **four storeys**. The architectural concept is defined by its emphasis on openness and multi-functionality, with particular focus on creating an environment that supports communication and interaction. A defining feature is the central **open atrium**, topped by a glass roof and interlinked by a sculptural, multi-level stair configuration. The original structural concept was based entirely on **beech (Baubuche by Pollmeier)**, incorporating double beams, girders, and columns. During the tender phase, WIEHAG proposed an alternative solution in **spruce**, which was ultimately adopted for its technical and economic advantages.

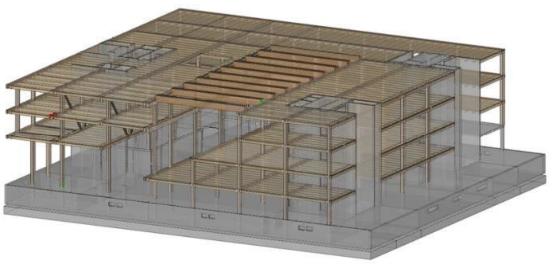

Figure 9 Office Bundesliga football club, tender model by WIEHAG

The timber engineering for the building was carried out by **Bollinger+Grohmann** in collaboration with **WIEHAG Timber Construction**. Following the design decision, WIEHAG developed the complete model in **Cadwork**, working in close weekly coordination with the structural and architectural teams via **IFC (Industry Foundation Classes)** file exchange (see Figures 9 and 10). The multi-storey structure is stabilised by **three reinforced concrete cores**, which provide lateral resistance and function as fire escape routes. In cantilevered areas – such as the entrance zone and sections of the atrium where columns do not continue to ground level – **steel structures** were introduced. These include both conventional steel framing and a **Vierendeel beam** system. The complete timber model was developed to fabrication level (see Figure 11). One of the architectural highlights is the series of **steel–timber hybrid staircases** within the atrium, which serve both structural and aesthetic functions (see Figure 10).

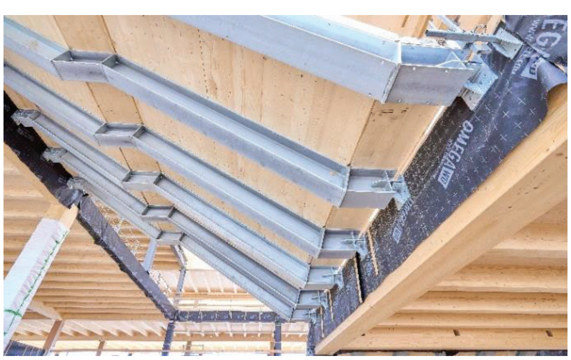

Figure 10 Office Bundesliga football club, stair in "Atrium"

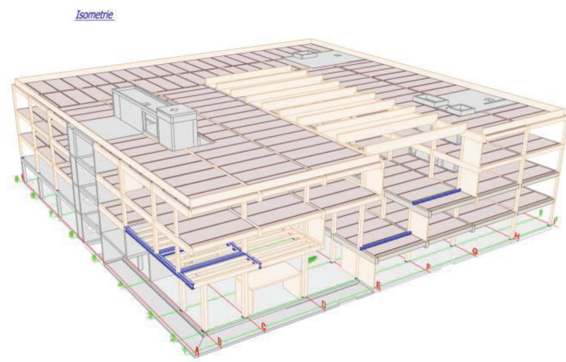

Figure 11 Office Bundesliga football club, finished workshop model

3 – CONNECTIONS AND WHY THEY ARE CHOSEN

The connections between individual timber components serve the same fundamental structural purpose across all three projects: the reliable transfer of forces between elements. However, the boundary conditions vary significantly depending on the project type. The following sections explain the key design parameters and justify the choice of connection systems used in each case.

3.1 WORLD OF VOLVO

In the *World of Volvo* project, the connection strategy was primarily shaped by three demanding requirements:

- **High rigidity** due to moment-resisting frame corners
- **Architectural individuality** due to varying cross-sections
- **High visual expectations** requiring concealed, non-visible connections

Global lateral stability was achieved through a combination of **portal frames with moment-rigid corners** and the **diaphragm action of the CLT roof deck**.

One of the most critical and complex connection points was between the columns and beams. These joints were not only architectural focal points but also structurally significant to overall frame stability. The connection was designed as a **moment-resistant frame corner capable of transferring bending moments of up to 2,300 kNm.** Internal steel parts were inserted into the main beams – some of which were up to **1,800 mm high and 420 mm wide** – using **fully threaded screws**, which transferred the moments through defined tension and compression zones. These steel components connected the glulam

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columns to the roof beams. The wood screws, up to **1,000 mm in length**, were **installed in the factory under torque control**, while the **final on-site assembly used time-saving steel-to-steel connections.**

To cover and conceal the access areas for these connections, more than **4,000 timber infill panels** made of three-layer boards were custom-fitted. These panels were test-fitted in the factory, with grain direction matched, and temporarily fixed on site adjacent to the connections. This prefabrication approach – developed through experience – helps prevent logistical complications or assembly errors during installation. **UV exposure, however, during temporary fixing can leave lighter marks on the timber surface**, particularly where the panels were attached. To minimize visible contrast, exposure to direct sunlight should be kept to an absolute minimum prior to final installation.

A non-structural curvature along the lower beam edge was executed via **machined shaping** rather than thin lamella bending, which would have required **impractical lamination depths (~15 mm)** in place of the **standard 41 mm**. In the final visual state, only a **mitre cut with a 10 mm shadow gap** remains visible.

The heart of the connection system is the **steel star node**, which connects to the structure at four points and serves as the most highly stressed connecting element of the supporting structure. This geometry is shown in Figure 12, a WIEHAG model of the node, highlighting the internal steelwork and the extensive array of fully threaded screws used to secure the timber beams. The real-world installation can be seen in Figure 13, which shows the beams assembled on site with cover plates enclosing the node.

This node was designed to resist **tensile and compressive forces up to 1,600 kN**, arising from the bending moments. Given the predominance of opening moments, the connection was designed such that:

• **Compressive forces** are transferred through **timber-to-timber contact** at the top edge

• **Tensile forces** are resisted by **fully threaded screws** inserted at 45°

• **Shear forces** are taken in the centre of the steel box via high-strength steel screws and additional **fully threaded timber screws into the glulam beam**

The connection was designed in accordance with **Eurocode 3 and Eurocode 5**, using a combination of **manual calculations and finite element modelling (FEM)** to optimise plate thicknesses and internal force distribution within the steel node. This rigorous approach provided additional safety margins for the highly complex force transfer mechanisms.

To minimise deformation and connection slip, an **extremely stiff connection** was required— achievable only through the use of diagonal screws and custom detailing. **Slotted-in steel plate dowel connections**, commonly used in timber construction, were not a viable alternative due to their relatively high flexibility and deformation under load.

As illustrated, the project placed extremely high demands on prefabrication. The glulam elements were assembled using only a few strategically placed steel screws – forming **high-performance, project-specific engineered connections**. Under forces of this magnitude, **standard off-theshelf connectors are insufficient**. This project exemplifies the **art of engineering through customised, innovative solutions**.

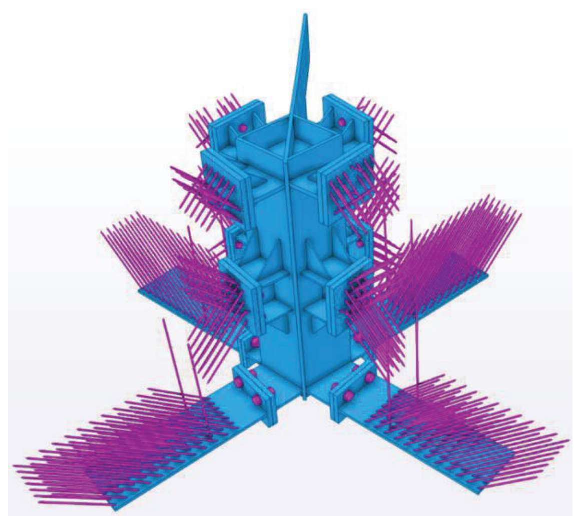

Figure 12 Star node by WIEHAG

Figure 13 Cover plates around star node

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3.2 EDEKA MARKTREDWITZ

The EDEKA warehouse project in Marktredwitz was divided into **three construction phases**, each tailored to specific functions. The **third construction phase** includes the high-bay warehouse and reaches a parapet height of **27 metres**, increasing to **36 metres** in some areas. These heights, combined with strict deformation limits and the **relatively poor soil conditions**, placed **high demands on the stiffening system that had to be developed** specifically for this structure.

Pure cantilevered columns were no longer feasible at this scale, as they were neither economically viable nor met the deformation performance requirements. As a result, a **hybrid column solution** was developed. The **inner glulam columns**, which reach up to **34 metres**, were designed as **pendulum supports** due to their low inherent lateral stiffness. **Partial fixity** was considered during the construction phase, but long-term structural modelling assumed pinned conditions. For the **external columns**, neither a full timber solution nor a full concrete column was acceptable—timber sections would have been too large, while concrete would have been too heavy for the site's ground conditions.

The adopted solution was a **composite column**, consisting of a **prefabricated steel–concrete base element** and a **rigidly connected glulam column** above. This approach delivered **high stiffness with low component weight**. The rigid joint was achieved using a **threaded rod system cast into the precast concrete**, into which the **butt-jointed steel connector** from the timber column was inserted and secured on site (see Figure 16).

To achieve global stability, the structure relies heavily on the **roof diaphragm**. The bracing forces are guided through the roof plane via **timber braces**, which transfer loads into the reinforced concrete wall panels. The **connections** between glulam elements in the roof were designed as **steel sheet–timber dowel connections** (see Figure 14), chosen for their **ductility** and **low visual impact**. Forces of up to **500 kN** occur in the diagonal members, and up to **1,000 kN** in the truss chords (see Figure 15). Figure 8 shows the bracing layout used in the high-bay warehouse section.

Due to the complexity of the interfaces and the fast construction schedule, **factory prefabrication** of connections was essential. Most connections were **fully pre-assembled** in the workshop. It was often **not feasible to insert screws or dowels on site**, especially in the tallest sections. On-site installation was therefore limited to **steel-to-steel joints**, enabling both speed and precision.

Temporary bracing systems and **staged assembly sequences** were used to manage wind loads and allow safe erection in partially braced states. The glulam columns and bracing elements were installed in carefully planned stages to ensure safe force transfer until the full roof diaphragm was complete and engaged.

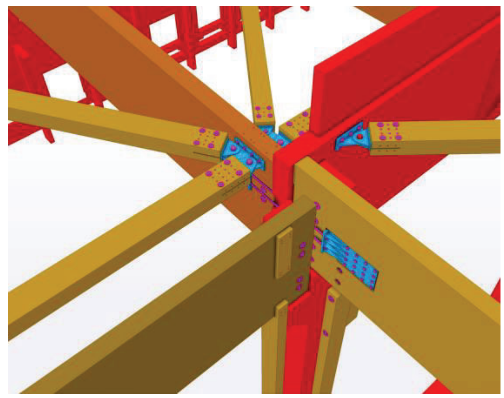

Figure 14 3D interface from timber to concrete with 1.000 kN load transfer

Figure 15 bracing of the roof

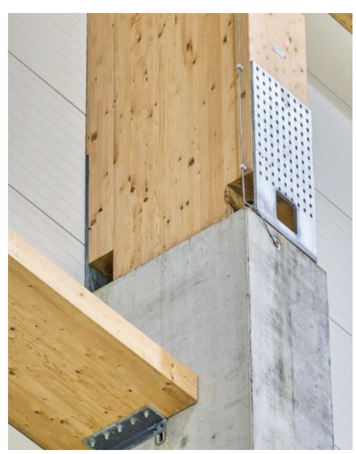

Figure 16 EDEKA, rigid joint of hybrid column

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3.3 NEW OFFICE OF A BUNDESLIGA CLUB IN LEIPZIG

In multi-storey timber office buildings, **connection systems must meet high visual standards**, allow for **repeatability**, and ensure **ease of installation**. These requirements were central to the design and delivery of the new four-storey, 14,500 m² office building currently under construction in Leipzig for a renowned Bundesliga soccer club.

Most of the **column-to-girder connections** were realised using the **Pitzl system** – aluminium dovetail connectors with angled screws driven at **45° into the timber**. These allow for **nearly invisible connections** between beams and columns, which was essential given the exposed structure and architectural expectations (see Figure 17).

Different connector sizes were used to accommodate varying load levels throughout the building. The system was designed to **streamline planning, production, and assembly**, particularly advantageous in a structure with a high number of repeated connections. This approach not only **enhanced construction efficiency**, but also **reduced the potential for installation errors**.

When selecting connectors, it was essential to consider both the **effective beam height** and the **activated beam width** to ensure optimal performance and structural integrity. In the absence of prescriptive Eurocode guidance for this specific connection system, **WIEHAG engineers applied internal design principles by reducing the effective load-bearing width in relation to the length of the fully threaded screws.**

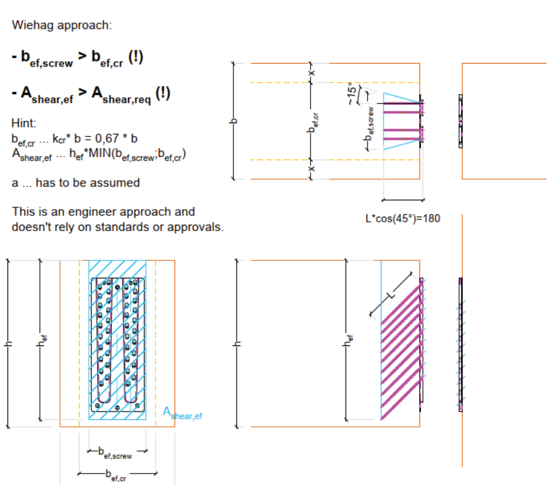

Figure 17 background of effective shear area

To achieve the required **floor spans of 8.1 metres**, rib panels were used. These consisted of a **CLT plate combined with glulam** secondary beams, which were **pre-glued in the factory** to ensure tight tolerances and rapid on-site assembly (see Figure 18).

Figure 18 glued rib panel 2,70 x 8,10 m

4 – CONCLUSIONS AND RECOMMENDATIONS

4.1 SUMMARY – WOLD OF VOLVO

The World of Volvo project represents a landmark in complex architectural timber construction – not only due to its size and geometry, but also the **enormity of the coordination and connection detailing involved**. Delivering a structure of this complexity was only possible through a high level of **digital coordination**, coupled with **extensive prefabrication carried out off-site by WIEHAG.**

Three tower cranes were shared among all trades, with **two typically allocated to WIEHAG** during timber erection. Installation was supported by a fleet of **mobile elevating work platforms (MEWPs)**, which ensured safe access to challenging connection zones – many of which involved concealed moment-resisting joints.

In total, **2,200 glulam and 2,750 CLT components** were installed over just **28 weeks**, averaging one timber element installed every **20 minutes**. Two crane teams and two installation crews worked in parallel. Remarkably, only **65 printed installation drawings** were required on site.

WIEHAG coordinated the entire timber package using **Trimble Connect**, with **Stora Enso's CLT360 platform** used to manage CLT component logistics and installation tracking. On site, **tablets and mobile phones** were used to complement printed drawings and assist with real-time issue resolution – an approach that reflects

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the broader trend across the timber industry toward embracing new technologies.

Given the scale and complexity of the structure, **minor challenges were inevitable**, but these were solved quickly through **remote screen-sharing sessions** between WIEHAG's engineering office in Austria and the site team in Gothenburg.

Water management during construction was a critical focus. All glulam members were delivered with a **two-pack clear hydrophobic UV coating** to reduce moisture absorption and surface degradation during installation. **CLT joints were taped immediately after placement** to prevent water ingress at panel edges. The role of the **roofing contractor was especially important**, with the **watertight membrane applied immediately after each installation phase,** ensuring that the structure was rapidly sealed and protected from weather exposure. These measures helped maintain the quality of all timber elements and ensured a dry envelope was achieved without delay. Figures 19-21 illustrate key stages of installation, including the central star node, atrium beams, and prefabricated connection zones.

The successful delivery of such a complex and demanding structure was made possible by the early engagement, close collaboration, and effective teamwork between all project stakeholders. The **bold architectural concept in timber by Henning Larsen Architects** aligned closely with the client's ambition.

Lindner Scandinavia, led by **Stefan Abrahamson**, provided the key scope of works for the project – including WIEHAG's structural timber, the ceilings, and the façade. Their contribution was crucial in keeping the project on track.

BRA Bygg, the local building contractor, coordinated the many specialist trades involved with precision and control – conducting this complex orchestra into a highly tuned final result. And perhaps most important of all, the initiative and generosity of **Volvo** in choosing to invest in a landmark timber building has left the **City of Gothenburg** with an enduring and meaningful contribution to its built environment.

Figure 19 Birdview during installation of timber structure

Figure 20 Mock up, World of Volvo

Figure 21 Essembly of Worlf of Volvo

Facts
Project name: World of Volvo
Client: World of Volvo
Location: Gothenburg, Sweden
Typology: Experience Center and meeting place
Concept: 2018 / **Construction Start:** 2020
Expected Completion: 2023
Inauguration: 2024
Size: 22,000 m^2 ; 110 m Diameter, 6,000 m^3 of mass timber
Certifications: LEED Gold and WELL Gold
Main contractor: BRA Bygg
Architect: Henning Larsen
Landscape: Henning Larsen
Renders: Kvant1
Clients Structural Engineer (ground/concrete/steel): Optima Eng. AB & BRA Teknik
Façade and Interior claddings by Lindner Scandinavia AB
Timber Structure: Engineering, Production & **Installation** by WIEHAG Construction GmbH

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4.2 SUMMARY – EDEKA LOGISTICS CENTRE

On-site execution at the EDEKA logistics centre presented significant challenges—particularly in the **36-metre-high sections** of the high-bay warehouse. At this height, it was often **not possible to install screws or dowels on site** due to access limitations and safety concerns. As a result, all critical fasteners were **pre-installed in the factory**, with only **steel-to-steel connections** performed during assembly. This approach significantly increased **safety, accuracy, and efficiency**.

The structural complexity and high loading demanded a carefully staged construction methodology. **Temporary bracing systems** were used throughout to manage wind loads during partially completed states and to safely distribute forces during progressive installation. Both the **untwisting of the timber supports** and their **temporary bracing up to the state of a fully braced roof** were considered, and the **sequence was precisely defined** to maintain structural stability throughout.

To avoid **load exceedances in connections and bracing** during intermediate stages – before the full bracing system was effective – **wind loads were partially reduced** by initially assembling the **precast wall elements only up to a limited height**. Once all components of the overall bracing system were in place, **the walls could be extended to full height and tightened**, completing the structural load path.

Installation sequencing was critical to maintaining overall stability, particularly for the long-span roof structure and hybrid columns. Each phase was coordinated to ensure that loads were safely and gradually transferred as the system reached its full structural state. Figures 22-24 show key aspects of the on-site execution, including pre-assembled elements, temporary support strategies, and the completed high-bay structure.

Figure 22 Essembly of Logistics Centre

Figure 23 Interior View of Logistics Centre

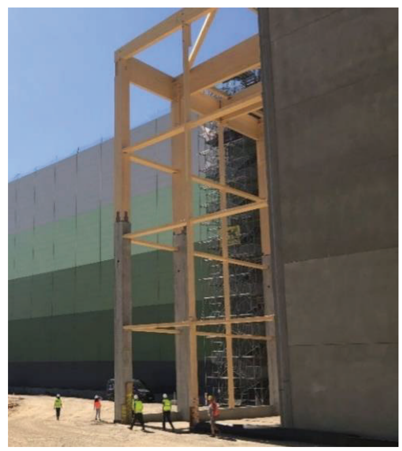

Figure 24 Exterior View of Logistics Centre

Facts
Client: EDEKA Nordbayern Bau- und Objektgesell-schaft mbH

Architect/planner: pbb Planung + Projektsteuerung GmbH
Structural engineering solid construction: pgs engineering
Planning/execution solid construction: KLEBL GmbH
Structural engineering/ planning/ execution timber construction: WIEHAG Timber Construction GmbH
Roof area: approx. 110,000 m²
glulam Volume: 15,000 m³
Construction time WIEHAG: September 2022 - July 2023

4.3 SUMMARY – MULTI-STOREY OFFICE BUILDING

A significant recent achievement in engineered timber is the new office building for a **major German football team.** The four-storey, 14,500 m² structure showcases the benefits of **repeatable, pre-engineered systems** in multi-storey mass timber applications.

In total, **380 rib panels** were installed, of which around **260 were identical** – a high degree of repetition that enabled streamlined production and rapid installation. **It was WIEHAG's first project to use a full 3D transport design in Cadwork.** All ceilings and timber construction components were **grouped on modular transport frames for sequenced delivery to site**, ensuring smooth logistics and efficient installation. **As a result, the construction site did not experience any truck downtime**.

The complete structural timber frame was erected in just **10 weeks**. Immediately after each level was installed, a **waterproof membrane** was applied to seal the timber deck from above. Detailing included the sealing of junctions between the **reinforced concrete cores and timber floors, as well as the protection of exposed column end grain and vertical upstands at concrete interfaces** – ensuring all timber remained dry throughout the build. Figures 25 and 26 show the ribbed floor system and the overall structural installation during construction.

Figure 25 Interior View, Bundesliga soccer club, Leipzig

Figure 26 timber protection on all floor areas

4.4 FINAL CONCLUSION

For timber construction projects, it is essential to consider the connection design at an early stage. Different building types – and the specific requirements of each client – lead to different connection strategies. Bringing experienced timber engineers and contractors into the project team from the beginning provides cost certainty, planning security, and contributes to higherquality outcomes.

Timber construction has proven that it can now achieve large structural dimensions – and do so economically. It offers new, material- and cost-efficient solutions, reduces the scale of required construction machinery, and supports the conservation of resources. Due to the high level of prefabrication, a significant part of the work shifts from the construction site to the planning phase.

To manage this complexity, the introduction of BIM-based methods (Building Information Modelling) across all trades is essential. Rather than being a barrier – as it is sometimes perceived in practice – BIM is a natural evolution in the construction industry. In all three of the projects described, BIM methods supported precision in assembly and made it possible to meet demanding construction timelines.

Timber construction makes a significant contribution to sustainability and climate protection. It offers innovative, low-impact solutions for a more environmentally responsible built environment. However, a truly sustainable construction industry will require broader changes – including cultural, regulatory, and supply chain shifts.

Still, wood is always the first step toward a more sustainable future. It contributes to climate protection in many ways and must be used more extensively as a building material – not only in industrial buildings, but especially in multi-storey residential and office construction.

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