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THINK IN CRONCRETE BUT BUILD IN WOOD - MODERN LIVING WITH SUSTAINABILITY AND TS3-TECHNOLOGY

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ABSTRACT: The example of the residential building project "Im Zelg" in Switzerland shows that it is possible to "plan in concrete but build in wood" by using TS3 technology and involving all parties even after the contract has been awarded as a concrete construction. The paper shows how it is possible to switch from concrete to timber, thus making an important contribution to climate change. It shows the organisation, logistics and quality assurance on a large construction site and the positive impact on the CO_2 balance compared to building in wood instead of concrete. This project is an impressive example of how sustainability and innovative construction technologies can go hand in hand.

KEYWORDS: timber, residential building, TS3, end grain bonding, new technology

1 INTRODUCTION

The transition from traditional concrete construction to sustainable wood building methods poses a significant question: "Planned in concrete, but built in wood – is it feasible?" The TS3 technology demonstrates that this shift is not only possible but also contributes significantly to combating climate change. By focusing on organization, logistics, and quality assurance on large construction sites, the implementation of wood as a primary building material can be effectively managed. The environmental impact, particularly the CO_2 balance, is notably improved when using wood instead of concrete.

This paper explores the feasibility of switching to wood, highlighting the technological advancements, operational strategies, and environmental benefits associated with this transition. By comparing the carbon footprint of wooden structures to that of concrete ones, it becomes evident that wood construction offers a more sustainable alternative, promoting a greener future in the building industry. The example of the development of the project "Im Zelg" in Uster shows all perspectives and advantages [1] of "Planned in concrete but built in wood!"

2 BACKGROUND

This study examines the challenging transition from traditional solid concrete construction to timber construction in a large-scale residential project in "Im Zelg" in Uster, comprising five apartment blocks with a total of 164 rental flats. Initially planned as solid buildings with timber façades only, the project was reoriented to be completed as timber construction driven by the client's commitment to sustainability even after the contract has been awarded. This decision necessitated a comprehensive analysis and adaptation of the construction approach at this late planning stage. Rhomberg Bau, the overall contractor undertook an in-depth evaluation of feasible timber construction methods, resulting in the development of the "From Solid Construction to Timber Construction" variant. The primary technical challenge was to devise a timber construction system that could structurally support a bi-axial load bearing timber framework across the apartment blocks. With collaborative efforts of the contractor, engineers and the new TS3-technology, the idea was further elaborated and led to the successful conceptualization and validation of this innovative approach, demonstrating its practicality and sustainability.

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Thanks to the close cooperation between Rhomberg Bau AG, Renggli AG and Timber Structures 3.0 AG, the project was successfully rescheduled on time, even at the advanced stage. This seamless coordination ensured that adjustments could be made efficiently without compromising the overall schedule. The innovative TS3 technology allows for a structurally biaxial tensioned timber construction, eliminating the need for visible beams. As a result, the spaces can be designed with a sleek, open aesthetic while maintaining high structural integrity and stability.

3 PROJECT DESCRIPTION

This development, consisting of five residential buildings and a total of 164 rental apartments, showcases the potential of timber construction to provide ample living space while promoting a modern and nature-oriented lifestyle, compare Figure 1. The apartments are designed with contemporary and well-thought-out floor plans that enhance living comfort, as shown in Figure 2. The interior view reveal, demonstrating the aesthetic and functional benefits of TS3.The floor plan of the project showcases the comprehensive layout and efficient use of space, see Figure 3. Details of the project "Im Zelg" are given as overview in Table 1.

Table 1: Project overview with key information

Building owner	Turintra AG, c/o UBS Swiss Mixed Sima Fund Management AG
Overal contractor	Rhomberg Bau AG
Timber Engineering	Renggli AG with Timbatec Holzbauingenieure Schweiz AG
Timber system construction	Renggli AG with Timber Structures 3.0 AG
Building type	Residential building 5 Multi storey houses 164 apartments in total
Building year	2024 – 2026 Building 5 and 7 | March 2025 Building 9 and 11 | Oct 2025 Building 13 | June 2026

Figure 1. Visualization of the project "Im Zelg": top view on all five apartment buildings. Source: TS3 and www.zelguster.ch

Figure 2. Visualisation of the interior of the rental apartments of the "Im Zelg" project. Source: www.zelguster.ch

Figure 3. Floor plan from the first to the third floor along the main axes measuring approximately 36 x 26 metres. Source: Renggli AG

4 TS3 TECHNOLOGY

4.1 GENERAL

Pioneering the future of sustainable timber construction, TS3 is a new technology two reach infinity biaxial load bearing CLT plates. As the leading solution for large-scale timber construction, TS3 allows for column spacings in grids of up to eight-by-eight meters, making it possible to use wood for expansive buildings and bold architectural designs. This was the key technology that enabled the transition of "Im Zelg" from traditional concrete construction to a sustainable, multistorey apartment house in timber.

Representing the next generation of timber construction, TS3 is the result of over a decade of intensive research in collaboration with the Federal Institute of Technology in Zurich and the Bern University of Applied Sciences. The breakthrough lies in a rigid, bend-resistant jointing technique for cross-laminated timber slabs, achieved through a specialized pouring-to-solid process. After more than 2,000 tensile and bending tests, the technology is ready to use, [2]-[7]. Now, the TS3 innovation

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enables the creation of joist-free, timber-frame structures with slender, point-supported slabs, paving the way for more sustainable and aesthetically striking architectural solutions.

4.2 THE TS3 JOINING

The fundamental technology of TS3 is the TS3 connection by edge joint grouting at a distance, without pressure and any other connecting means. This facilitates the production of panels of any size, enabling the construction of beamless timber structures with slender, point-supported slabs. Figure 4 illustrates the construction process in a simplified manner, delineating the following stages: (a) the initial arrangement of CLT plates on temporary supports and beams. A 4 mm gap is maintained between the plates. The end faces are prepared with a pre-priming process, which is undertaken to protect the opaque surfaces and to secure the bonding process. (b) the casting resin is then filled into the joints, section by section. (c) after a period of several days, the casting resin has hardened, and the temporary support can be removed. (d) the building is completed. This innovation has enabled the transition from hybrid to fully timber constructions.

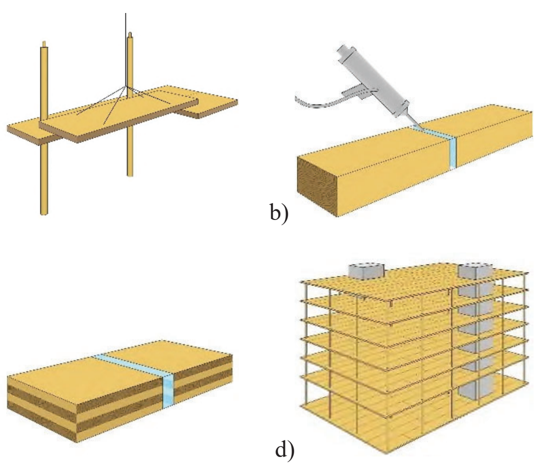
a) b) c) d)

Figure 4. TS3 technology: stepwised illustrated, a) the layout of the single CLT plates, b) the puring process, c) the bi-axial CLT plate as continuous floor slab and d) the final building, Source: Timber Structures 3.0 AG

4.3 ADVANTAGES OF TS3-TECHNOLOGY

Historically, concrete construction maintained a distinct advantage due to its ability to create structural elements capable of bearing loads in multiple directions, such as floor slabs. Second-generation timber construction lacked this capability, limiting its application in large-scale projects. However, this constraint has now been overcome. With TS3 technology, timber construction has reached structural parity with reinforced concrete, even for extensive load-bearing surfaces.

TS3 enables wood to replace reinforced concrete in most structural applications, offering a significant environmental advantage. The production of steel and cement - essential components of reinforced concrete - is highly energy-intensive and a major source of CO_2 emissions. Globally, reinforced concrete accounts for approximately nine percent of human-induced CO_2 emissions. In contrast, wood acts as a carbon sink, continuing to store CO_2 even after installation. By replacing steel and concrete with wood, TS3 facilitates sustainable construction solutions across various building types, directly contributing to climate protection.

4.4 STRUCTURAL SYSTEM

The structural system of the six-storey building is based on a skeletal structure with floor slabs and vertical load-bearing elements in the form of columns and load-bearing walls. The dead and traffic loads on each floor are carried by the floor slabs, which transfer the loads vertically through the support points to the columns and walls below and ultimately into the ground. Horizontal loads, such as wind and seismic forces, are absorbed by a centrally located concrete core, which also acts as a staircase. This core provides the lateral stability of the building by transferring horizontal forces into the ground, providing the necessary structural integrity and deformation control. The combination of floor slabs, load bearing walls and the central concrete core results in a slender yet robust structural system.

In the structural analysis, the floor slabs were designed as biaxial load-bearing elements using CLT panels. The segmentation of the complete floor slab into the individual CLT plates was determined based on deformation and stress distribution to ensure efficient load transfer. The segmented slabs are supported by either load bearing walls or columns. Figure 5 shows the floor plane with the individual CLT plates which are bonded to biaxial members using TS3. The static floor slabs, therefore, reach dimensions from 8 x 8 metres up to 8 x 10 metres. The TS3 configuration facilitates the activation of secondary load direction, thereby enabling the construction of slabs of specified sizes using conventional cross-laminated timber (CLT), whether the material is wood or concrete. The utilisation of conventional cross-laminated timber (CLT) eliminates the requirement for supplementary static beams, which are typically employed in conventional load transfer systems. The structural performance is shown in Figure 6 to Figure 8 with the bending stress and shear stress distribution as well as the global deformation.

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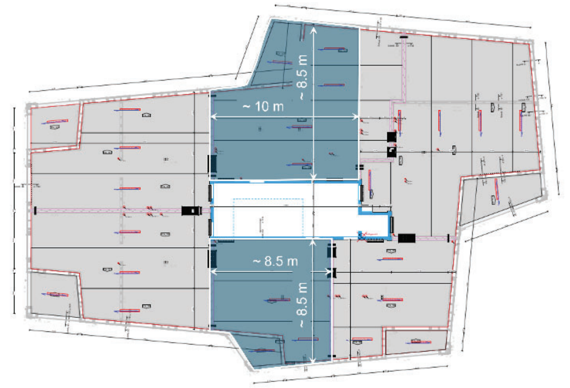

Figure 5. Floor plan with the segmentation of CLT plates layout and glued together using TS3 technology. Two statical floor slabs ara marked to show the dimensions reached without additional static beams, Source: Timbatec Holzbauingenieure Schweiz AG

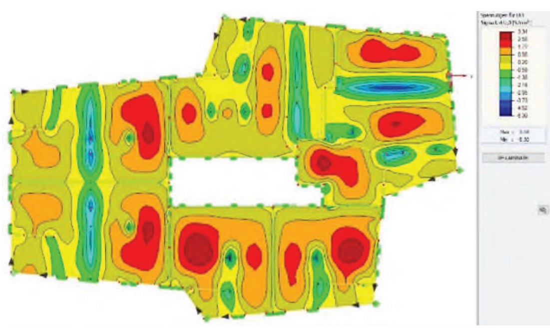

Figure 6. Bending stress distribution of the whole floor. Source: Timbatec Holzbauingenieure Schweiz AG

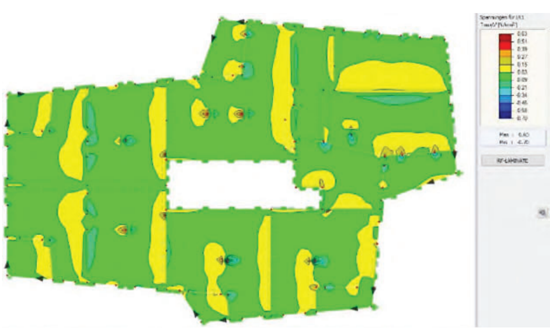

Figure 7. Shear sress distribution of the whole floor. Source: Timbatec Holzbauingenieure Schweiz AG

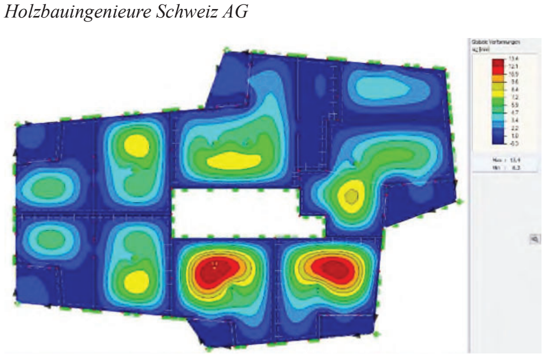

Figure 8. Deformation distribution of the whole floor. Source: Timbatec Holzbauingenieure Schweiz AG

5 STRUCTURAL DETAILING OF THE COLUMNS

In the structural system of the building, columns and walls are responsible for vertical load transfer. This chapter deals with the design and construction of the columns. The columns are made of Beech LVL (GL75) [8] which provides high load bearing capacity and dimensional stability. The column joints are located at the level of the floor slabs to allow for efficient erection. Internal steel elements have been incorporated to facilitate direct load transfer by contact, precise positioning, and accurate column alignment during erection process, see Figure 9.

The steel elements were pre-assembled at the top and bottom of each column at the manufacturing plant, allowing for easy on-site placement. In addition, localised cross reinforcement was used to increase load capacity and minimise deformation. These design measures effectively reduce settlement to a minimum, ensuring high precision and long-term structural stability.

The steel elements are embedded within the columns and protected by the floor construction, ensuring effective fire protection.

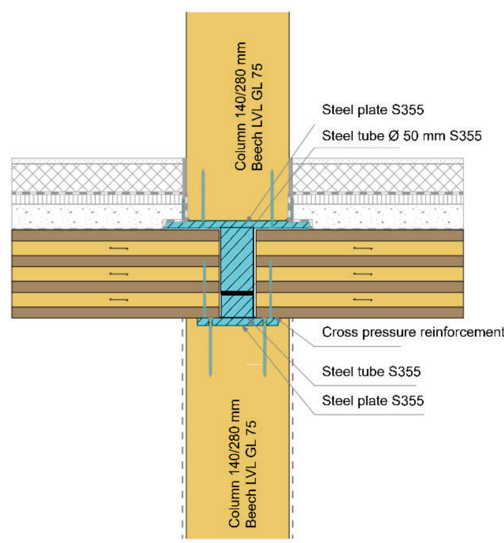

Figure 9. Column joints at the level of the floor slabs with internal steel elements for direct load transfer according to Renggli AG

6 BUILDING PROCESS AND EFFICIENCY

The construction of the houses proceeded as planned and without delays, as the repetitive floor plans and standardized slab geometries allowed for a fast and efficient assembly. All slabs were pre-cut to the required dimensions in the factory, eliminating the need for time-consuming adjustments or cutting on-site. The slab end faces were pre-treated with a primer at the factory and transported protected against moisture impact. This ensured high-quality execution of the TS3 technology, which was also subjected to a quality assurance plan, including documentation and sample testing for verification.

The assembly followed a clear, cyclical process: The elements were laid out floor by floor, final preparations were made, and the slabs were then joint by pouring the glue into the 4 mm gap. After several days of curing, the same process was repeated on the next floor and later in the following building. In total, four houses were constructed continuously, even through the winter season. Special attention was paid to the temperatures during the grouting process to ensure they did not fall below 5°C. Therefore, the fifth house is scheduled to begin after a planned break.

Figure 10 shows a bird's eye view of the site with the construction of the first house, the already constructed core for house 2 and the basement for house 3. Figure 12 shows the wooden ceiling with TS3 and the bottom view of a finished TS3 ceiling. The temporary support is still being removed. This structured and repetitive construction process resulted in high efficiency. Long storage times on-site were avoided, construction spaces were minimized, and an optimal workflow was ensured. As a result, an early move-in was even possible as early as March 2025.

Figure 10. Top view on the construction site of "Im Zelg" in Uster. The first building is being erected, the concrete core of the second building is being built and the basement for building 3 is being constructed. Source: Timber Structures 3.0 AG

Figure 11. View of the construction site at the beginning of 2025, with the first building erected and buildings 2 to 4 in various stages of construction in the background. Source: Timber Structures 3.0 AG

Figure 12. Construction site of "Im Zelg" in Uster: Floor-panel layout (top), preparation of bearing support and inside view under construction (bottom), Source: Timber Structures 3.0 AG

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7 ADAVANTAGES AND CONCLUSIONS

Converting an already planned solid construction into a timber construction, previously unthought and doubted, is made possible with TS3 technology. This residential development demonstrates this capability, being built with sustainable materials and storing CO_2 for a lifetime. The project exemplifies innovative timber construction, contributing significantly to long-term sustainability.

A thorough analysis by Rhomberg Bau AG identified cost-efficient measures that ensured the project remained within its budget constraints. The case study will detail the ecological responsibilities and efficient construction processes that characterized this project, highlighting the use of TS3 timber floor elements and the accelerated construction timeline achieved through high prefabrication. These strategies not only balanced the additional costs of timber construction but also adhered to the overall project budget, demonstrating both sustainability and cost-effectiveness in modern building practices.

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