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The Albizzia Tower

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Abstract The 53-meter tall Albizzia Tower is a white, mineral building with a mixed concrete and wood structure. It harmoniously interacts with the high rises of La Confluence. Its base is largely open, in direct relation to the public space. The spaces are mutable, reversible, moldable thanks to a streamlined structure: posts, beams in glued laminated wood, with posts pushed back on the facade to facilitate the layout of office and housing floors, CLT floors with a span of 7 meters.

Keywords timber tower, innovative concrete façade, ultra-high-performance fiber-reinforced concrete, fire safety in timber frame, CLT, prefabrication

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1. Introduction

In France, the Albizzia tower takes its place on the podium of three highest timber-frame towers. At 53 metres high, the Albizzia tower in Lyon is what you might call ‘a large-scale building’, by comparison with the ‘towers’ shown in the CTBUH Journal, which are generally some 150m high – if not soaring towards the kilometer mark. Nonetheless, it constitutes (yet another!) demonstration that it is possible to make tall buildings in wood today.

Winner of the 2018 competition for the design of the ‘Albizzia’ city block of four buildings in Lyon’s Confluence district, HARDEL LE BIHAN ARCHITECTES have designed the residential and office tower, and a building containing social housing. while the Lyon-based practice Insolites Architectures is completing the development with the two other buildings – one residential and one offices.

The tower has a double client, Woodeum and UTEI, and is being built by Lebras Frères, specialist carpenters involved in the restoration of Notre Dame cathedral in Paris.

The site is set within a quadrangular urban plan designed by Herzog & De Meuron,* composed of urban blocks that are partly open. It is located in the area that regroups the taller buildings in the Confluence district.

The development authority’s brief set out ambitious social, environmental and architectural goals. The planning requirements were strict:

- Durable construction / facades,
- Pale materials to ensure coherence of the new buildings within the district,
- Low-carbon construction,
- Very short construction times to avoid disruption of the neighboring primary school.

Timber construction meets two of the main requirements identified above, while the use of ultra-high-performance fiber-reinforced concrete (UHPFRC) in the facade meets two others.

2. Innovative Concrete Facade on a Timber Structure

What really sets the project apart is the use of a pre-fabricated UHPFRC facade mounted on a timber structure.

Given the highly innovative nature of this type of construction in terms of both materials and the way in which they are used, standardized technologies were not suitable. Consequently, an ATEx (*Appréciation Technique Expérimentale*) procedure had to be put in place. This is the French system for the technical and regulatory approval of innovative and experimental technology.

As part of this procedure, the facade design was presented by the client and relevant contractors to a technical commission from the CSTB (Centre Technique et Scientifique du Bâtiment), the French building standards organization, which ensures the quality and security of buildings by means of research, expertise, evaluation and certification.

This procedure provided full technical authorization and approval for the facade design.

3. Fire Safety in a Timber-frame Residential Tower

The other major issue was fire safety. The enormous media coverage that followed the tragic Grenfell Tower fire in London on the night of 13/14 June 2017, with a

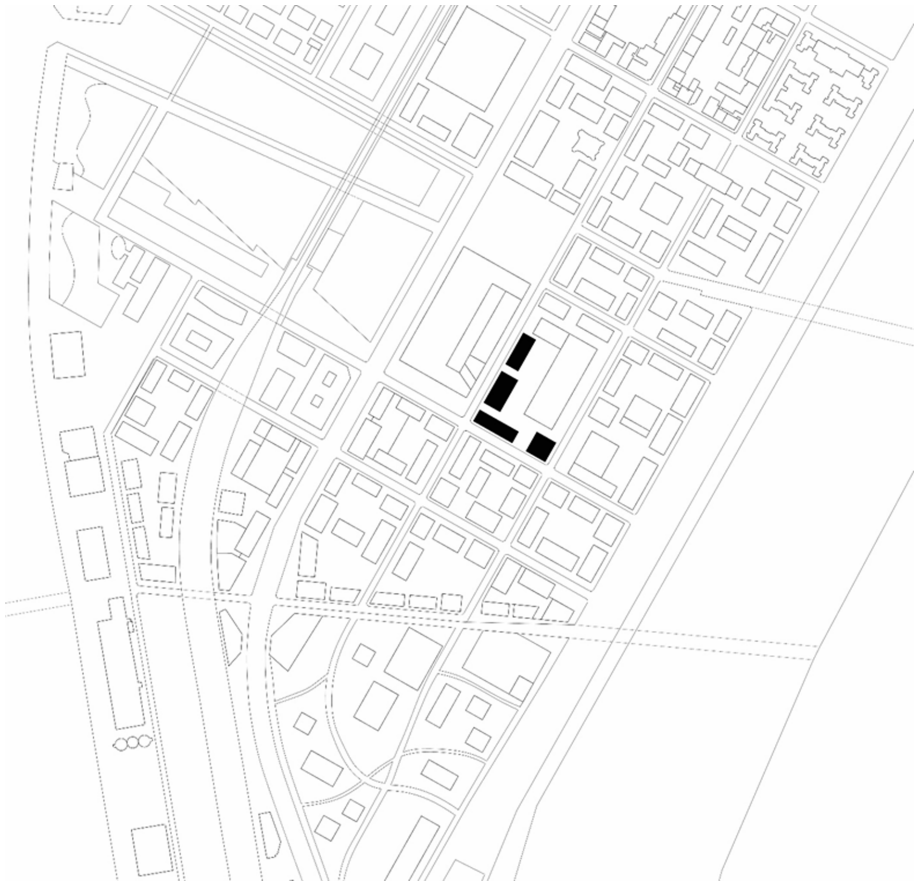


Figure 1. Location plan. ©Hardel Le Bihan Architectes

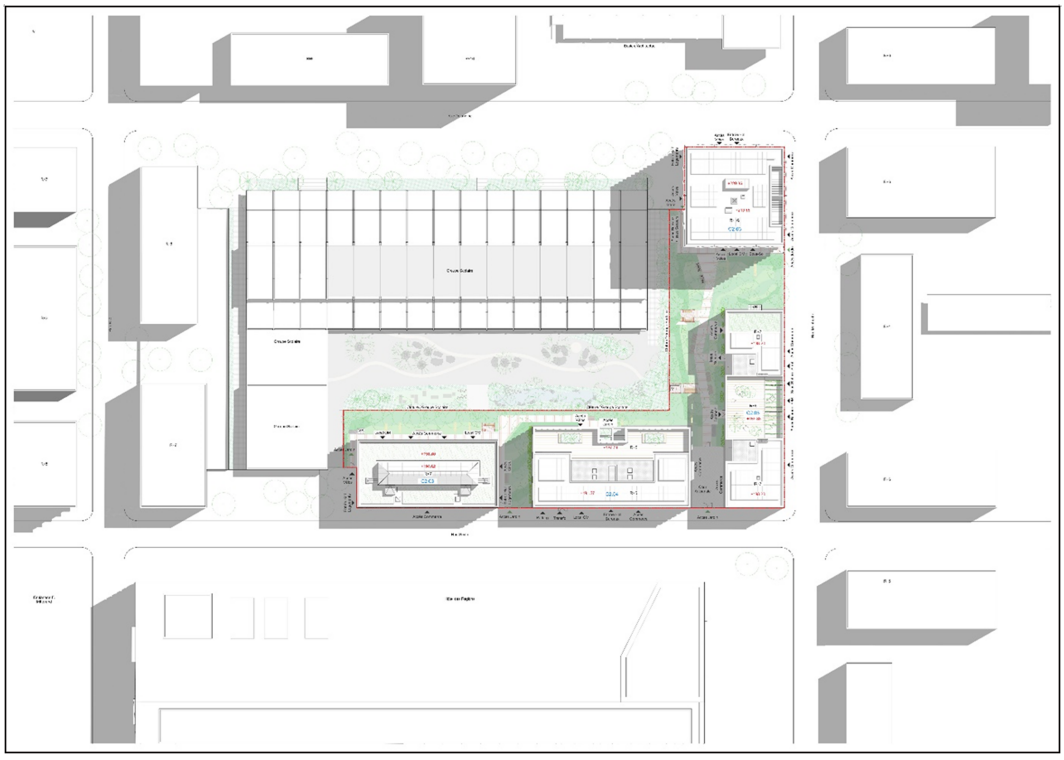


Figure 2. Site plan. ©Hardel Le Bihan Architectes



Figure 3. Albizzia tower. ©Kevin Dolmaire

death toll of 79 people, prompted public authorities to speed up the process to revise standards for fire safety measures in residential buildings.

In August 2019, when designs for the Albizzia tower were in full flow, fire safety regulations for residential buildings were broadly modified, increasing the requirements for facades, in particularly with regards the fire resistance properties of external cladding.



Figure 5. Albizzia tower under construction march 2024. ©Kevin Dolmaire

In addition to the obligation to protect the internal load-bearing structures by covering them with a physical protective



Figure 4. Aerial view. ©Harder Le Bihan Architectes and Insolites Architectures



Figure 6. Façade construction detail. ©Kevin Dolmaire

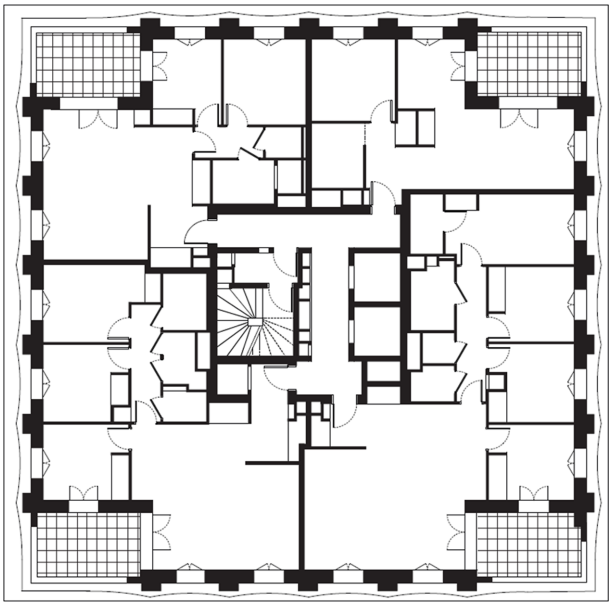


Figure 8. Typical residential floor plan. ©Hardel Le Bihan Architectes

layer, we also had to ensure that all the materials used in the facade (and the balconies) met with the new fire-resistance performance ratings reducing the combustible mass and thereby minimizing the risk of fire propagation between floors.

This level of complexity required sustained collaboration between architects and engineers, accompanied by the developer's R&D team at Woodeum.



Figure 7. Balcony under construction. ©Kevin Dolmaire

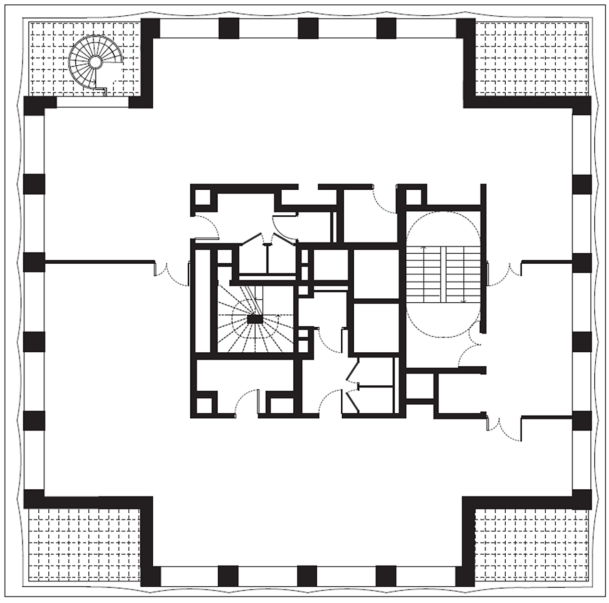


Figure 9. Typical office floor plan. ©Hardel Le Bihan Architectes

4. Mixed-use Programme and Quality Housing

The building base houses retail units, entrances, and two floors of offices. The subsequent 13 floors are entirely residential and contain 56 apartments. The tower's overall floor surface is 5,400 m^2.

Within the imposed square plan (22 × 22 m), the architects and engineering consultants for the timber structure worked together to devise high-quality apartments that are very open (30% glazing), functional and flexible for the future, resulting in adaptable housing units that can modified to evolve and reinvent themselves. The columns were originally positioned and dimensioned within the building envelope. Subsequent to the competition, we worked on moving the columns outside. Architecturally, this frees up internal space and brings an interesting aesthetic tension to the facade.

The services are grouped around the core to create service areas in the central zone, making the apartments as modular as possible and freeing up the facades and thereby views from the living spaces.

All the apartments are dual aspect, extended by 10 m^2 loggias at the corners, and all the living spaces face east, west or south. None is north-facing.

5. Off-site construction

The structure is mixed, with a base and core in concrete to provide lateral stability and meet local seismic requirements. With the exception of the core, all elements were pre-fabricated off site: the base (floor slabs and facades made using slip-forming), timber structure, and facade elements in UHPFRB.



Figure 10. Albizzia tower under construction showing the site-cast concrete core structure and prefabricated other structural elements including steel beams and CLT floors. ©Kevin Dolmaire

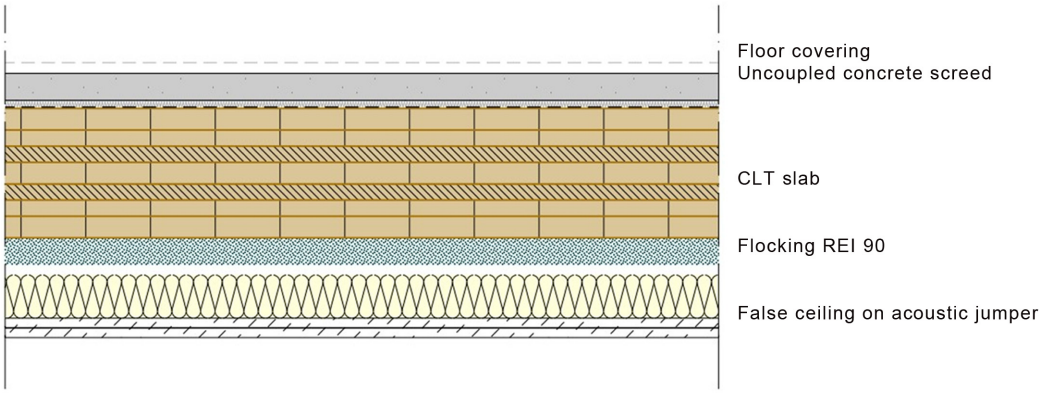


Figure 11. Albizzia tower's flooring. ©Hardel Le Bihan Architectes

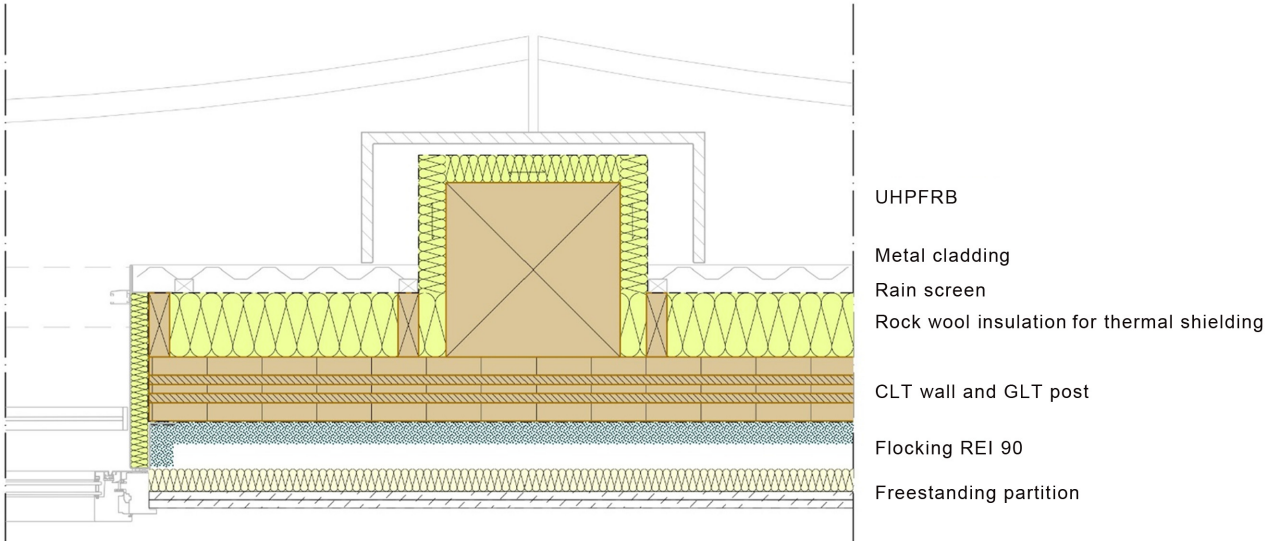


Figure 12. Albizzia tower's wall around the column. ©Hardel Le Bihan Architectes

6. Structure

The core transfers all horizontal loads to the foundations. The floor plates of CLT form a diaphragm that encircles the core, providing horizontal stability to the facades, which due to the building's height cannot provide for their own stability.

Having established this principle, the plan could be simple and clean. Thanks to the corner loggias, the result is four small-span primary steel beams (with no down-stand beam).

The floor slabs are simple and 'very French': a timber slab for the diaphragm, combined with a topping for added acoustic performance and, beneath the slab, a layer of spray-applied fire-resistive coating to meet fire safety requirements (90 minutes fire resistance and the structural timber does not participate in the internal calorific mass). The suspended ceiling completes the floor slab's acoustic performance and makes it possible to conceal cabling.

This scheme makes it possible to clear out the primary structure.

Conception of the walls: given the repetitive nature of the facades, which are identical on all four sides, and with the aim of reducing time on site, we looked closely at optimizing the number of elements to be prefabricated off site. As already mentioned, we opted for primary columns, spaced every 3.2 m to 3.6 m, connected by solid panels of cross-laminated timber onto which we added the facade elements in the factory, namely: vapor barrier, insulation, waterproofing, window casings (which house all the window joinery, blinds and railing fixings).

Overlapping requirements and processes throughout the project, such as this rational consideration of the future site while simultaneously working to ensure the quality of the finished spaces, before having even put in for planning permission, illustrate the collaborative energy that set a particular tone of adventure on this memorable project.

The balconies: the question of eliminating the columns in the corners in which the loggias are located was a



Figure 13. Albizzia tower under construction showing column-free balconies at the corners. ©Kevin Dolmaire

subject of discussion during design. To reduce the risk of differential settlement between thermally insulated internal structures and external structures (subject to climatic variations), and to accommodate the continuous bands of cladding, the choice was made to prefabricate L-shaped metal truss beams, independent on each floor and ensuring the projection of the balcony.

The absence of these corner columns opens up the views and projects the external spaces into the distinctive surrounding landscape of this confluence of two rivers.

7. Cladding in Ultra-high-performance Fiber-reinforced Concrete (UHPFRC)

The cladding in UHPFRC ensures the durability of the facade while reducing its weight, thereby perfectly suited to the supporting timber structure with its external insulation.

UHPFRCs are characterized by resistance in compression six times higher than that of standard concretes, as well as being much more aesthetically pleasing.

Their composition is characterized by a high level of binder, the incorporation of aggregates ground to millimetric granulometry, the use of reactive powder, the systematic use of organic fibers, and finally the addition of specific additives with high water-reducing properties.

Ultra-resistant, highly ductile concretes are thereby obtained, characterized by very low porosity and an extremely smooth surface finish.

Finally, their high mechanical resistance has made it possible to realize large elements, around 3.2 m long, with limited thickness of panels (around 25 mm), considerably reducing the weight of these elements.

The large panels are attached to the primary timber structure via stainless steel fixings. Both vertical and horizontal panels are held in the same way, the top fixings taking the dead weight as well as horizontal wind and seismic loads, while the lower fixings transfer horizontal loads to the supports.

Finally, these elements were designed to enable the facade facings to accommodate all the movement and tolerances of fitting and fabrication, as well as deformations in the primary structure.

During the ATEx procedure, a series of tests were requested by the CSTB's technical commission in order to approve the use of these elements:

- Test for mechanical robustness
- Test for seismic loading
- Test for impact loadings
- Test for pull-out of anchorages
- Tests of air- and water-tightness
- Tests of resistance to wind loading.

In order to capitalize on this type of predominantly timber construction for future projects, the developer, Woodeum, fitted the walls from site phase with connected moisture sensors in order to track day-to-day variations in the timber. The readings will continue until completion, or even beyond, as the sensors remain within the wall complex.

8. Conclusion

As presented in this paper, many initiatives to further innovation and research make the Albizzia tower a showcase building, a pioneering project for high-rise timber construction.

Appendix

*Herzog & de Meuron for the design of the master plan for the urban development zone, Atelier Ruelle for working up the decomposition of the lots and for site management.