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Milestone: Mass Timber "Senstation" in France

Nicolas Ziesel†

KOZ architectes, 12 impasse Mousset 75012 Paris France

Abstract Designed ten years ago Sensations is still the highest all mass timber residential building in France. As a pilot project it had many challenges to overcome, and as architects it was a clear milestone in our commitment towards the development of wood construction. We invite you to explore the design and technical (behind the curtain) aspects of the story.

Keywords CLT, France, mid-rise, residential, low-carbon, mass-timber

†Corresponding author:
Nicolas Ziesel
E-mail: nicolas@koz.fr

1. Introduction

This year we are celebrating the 10 years of a project that represents a milestone for our office, and for the development of mid to high rise wood buildings in France.

In 2013 the Urban Community of Strasbourg "CUS" launched a competition for a "wood and bio-sourced residential demonstrator neighborhood", the "Ilot Bois".

We had been advocating the development of mass timber for more than ten years and with a like minded team accepted the challenge to design and build the highest one in France. I will ask for your understanding, as this is an architect's testimony with plenty of shortcuts on technical issues, but I hope you will get a feeling of



Figure1. Ilot Bois.

the amazing adventure "sensations" - the projects nick name - has been!

2. The project

The project is located in the "Deux-Rives" area in the south-east of Strasbourg. A 250 hectares and 4700 new apartments public urban development on brownfields, linked to nearby Germany by a bridge crossing the Rhine and well connected by tramway to the city center.

The "Ilot Bois" was one of the last available plots of the masterplan divided into 4 plus a silo parking lot. Our part was a long plot: on an urban boulevard on the north-west, open views on the south/east, and with an expected 11 levels "objet merveilleux" on the North/east corner making an urban signal at the entrance of a huge urban leisure park (Fig. 1).

The suggested volumes implied a rather massive slab type silhouette with strong backlighting and almost half of the flats single oriented to the north/west with minimal sunlight. Instead we proposed a scenario of three "towers" ranging from eight to twelve levels. The towers are connected by a four level pedestal that creates a porch opening views from the street to the in between entrance plazas with the low greenhouses on the south/east limit that incorporate bicycle parking and services in a "social hub" encouraging residents towards sustainable mobility and access to the park.

All ground level facing public space is dedicated to professional and retail spaces, with the fun fact of seeing a wood-oven pizza restaurant settle in a mass timber building! (Fig. 2)

The "signal" tower should have topped at 31 meters, but by using multiple level apartments on the last floor allowed to dramatically extend it's crowning to 35 meters high, making it the highest 100% mass timber project - minus the ground level- in France. The slopped crownings of all three towers allowing the installation of photovoltaic panels facing the south.

Building in wood being more costly than conventional ways required us to keep volumes simple and compact. More so because we advocated to go further than the brief that limited mass timber to the upper levels, opening a whole range of technical and building code unknowns.

The suspended balconies bring a playful contrast that creates a dynamic silhouette.

Their shifts between levels allow every one of the 146 flats to have an outdoor space, open to the sky to convey a feeling of flying.

Keeping a sensory relationship to the outdoor, from the entrance to each flat's door enhances the living experience and we managed, even in these compact 20 × 20 meter layouts to offer natural light and a view to all corridors. In the same way almost all two and more bedroom apartments have a double solar orientation with as much as possible the living room benefiting from it.

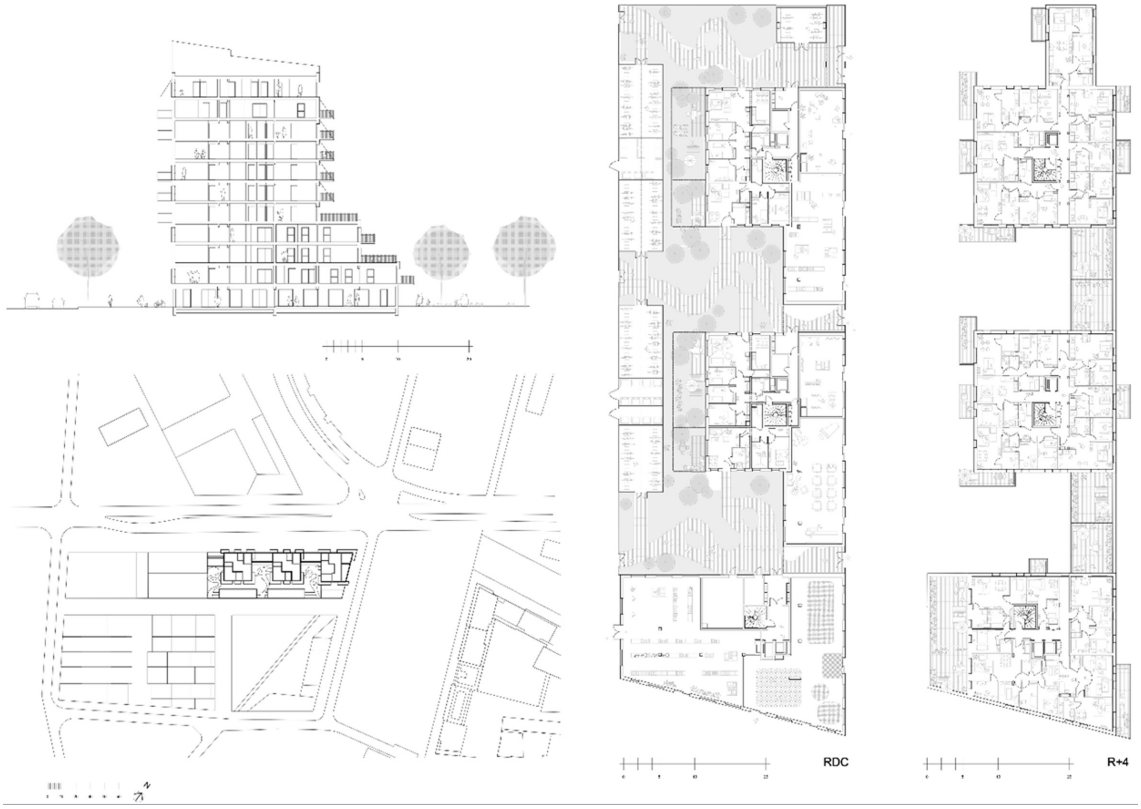


Figure 2. Project section "left top", site plan "left bottom", and floor plans "right".



Figure 3. Sensation.

For cost, structural lightness and maintenance issues a metal cladding was an obvious choice. But to give it a changing “moiré” effect that can blend it with the changing skies it is covered by a lace dress of expanded metal mesh. The balconies are in wood to bring contrast and offer the sensible touch of the material to residents.

The background color becomes golden on the pedestal level, a reminiscence of when it was supposed to be in wood, and we will see further why this changed! (Fig. 3)

3. Behind the curtain

3.1. Team Building

The design & build team led by Bouygues Immobilier Strasbourg - the local office of one of the major French developers - had architects and engineers accustomed to residential wood buildings “KOZ design lead, ASP partner architects, Ingénierie Bois -Thomas Steuerwald structural eng., AIDA acoustic eng.” and as Eiffage - one of the biggest in France - as general contractor. They had also secured an agreement with KLH, at the time the main European CLT manufacturer. Eiffage had participated in a CLT construction and was eager, under the guidance of it’s “off-site and low carbon direction”, to explore how it could train it’s workers to shift from prefab concrete to CLT panels. Even if the woodwork was ultimately done by a Altibois, a wood construction company who managed to raise the structure in less than 4 months with an impressively small team of 6 to 10.

3.2. Market

Even if Strasbourg is a rather dynamic market Bouygues Immobilier was making a gamble with such a big innovative project.

Possibilities of flexibility in floor layout where explored from the start - converting one of the three towers by a co-living for students and young workers for example - as escape routes in case putting 140 units on the market at once would not find a public, and being able to adapt to the changing landscape of fiscal incentives for residential investing (Fig. 4).

And, wouldn’t the “never done before” of such a large and high mass timber building frighten prospective buyers? For the commercial launch public presentation we were asked not to mention mass timber and focus on low energy needs, amenities and location. It turns out that for the Q/A session the first one was “I’m interested to buy, but can you confirm me it’s still a mass timber project?”. In a city close to Germany and Switzerland, and who would elect a green party council soon afterwards, that should have come as no surprise that a market for differentiation by sustainability was there!

3.3. Public involvement

Anticipating all the technical hurdles that all the “Ilot Bois” projects would have to overcome, the CUS had set a participatory method. Various experts were involved in a Quality Circle tasked to help the teams reach their goals through technical advice, and provide feedback to the Urban Community for capitalization on the lessons of this urban pilot on future programs.

Regular workshops brought together the teams, the CUS, the experts and all regulatory bodies - certifications of building standards, firefighters etc. - to discuss “code



Figure 4. Floor plans for different users.

red" issues, share approaches and keep all stakeholders updated. The diverging calendars of the teams loosened a bit dynamic but it was nevertheless fruitful in keeping everybody on track.

The CUS had also applied for funding through government programs in order to cover part of the expenses faced by the teams in technical tests and assessments with third body certification engineers.

Another aspect of this strong involvement is related to local economic development. Strasbourg is located near one of France's big forest areas, the Vosges. But from forestry to first transformation and second transformation of raw wood the industry was fragmented and lacking of perspectives to invest in new factories that could bring it at par with germanic and nordic European countries. The "ilot bois" was to give them access to a unknown before volume of work and bring confidence in the future by showing public support and encouraging designers and developers to shift towards more sustainable practices.

3.4. Fire

One such issue was of course fire safety. Firefighters are traditionally pretty confident with wood structures as they are dimensioned so the outer layer gets charred, preventing flames from reaching the load bearing core. Yet certificatory insisted that all wood structure in lift shaft and staircases be protected, so be it.

Local councillors had insisted that we keep a wood cladding on the lower levels because "otherwise no one will know it's a wood building!". Following Grenfell tower the "chimney effect" in the insulation layer between structure and cladding is a high risk. And with a wooden structure the risk is higher since the combustible mass of the facade is higher than with a concrete structure. A guide for technical solutions has been elaborated since 2016 and Sensations was used as a benchmark by realizing a full scale fire test -known as a LEPIR - even as construction was well under way. The test confirmed the necessity of protruding metal deflectors at every floor - that make a very noticeable architectural feature - and revealed a few issues. First that even with these deflectors a wooden cladding would propagate fire from level to level faster than expected.

Solution: replace it by a metal clading.

Then, that due to more environmentally friendly glue, the outer layer of CLT panels tends to delaminate at high temperatures, thus allowing fire to attack directly the core and weakening the structural capacity.

And finally that as wood has a low thermal inertia the building floor above the one on fire heats more rapidly than with a concrete slab. So when the flames reach this level by the facade the wood structure is pre-heated and combustion starts faster, thus reducing the fire grade of the structure.

For both cases the obvious path would be to install a sprinkler system. But since France has an aversion for it, solution: gypsum boards on all structural wood, bare the posts and beams in corridors after epic negotiations! (Fig. 5).

3.5. Structure

The general principal was to have outer walls and vertical core in CLT, with posts and beams to support CLT slabs in between. Yet, between the 8 level blocks and the 12 level one extra CLT walls had to be added to the floor plan for bracing considering it's geometry and the off-center position of the vertical core.



Figure 5. Wooden cladding under fire.

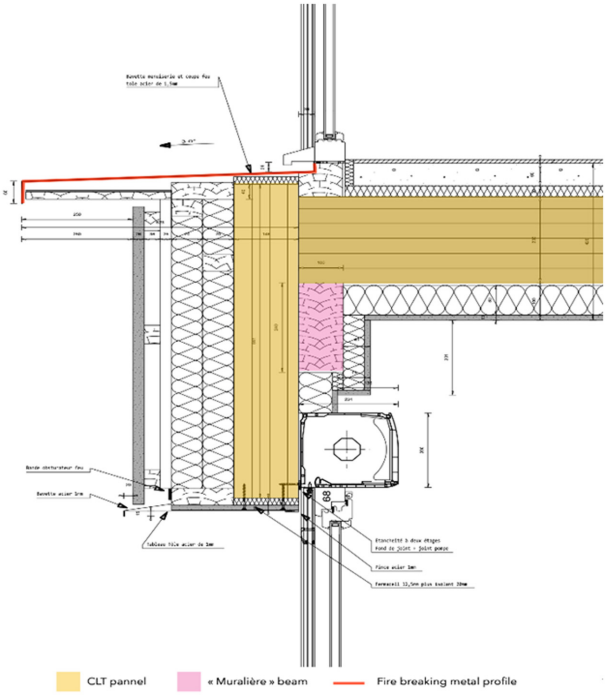


Figure 7. Section Detail.

Strasbourg is in a high seismic risk area and there was a bit of doubt with the first structural analysis showing lighter foundations than contractor or control engineers where used to. So the model was run on three different software’s to triple check and confirm. Diving deeper into the behavior of mid-rise CLT to an earthquake raised the

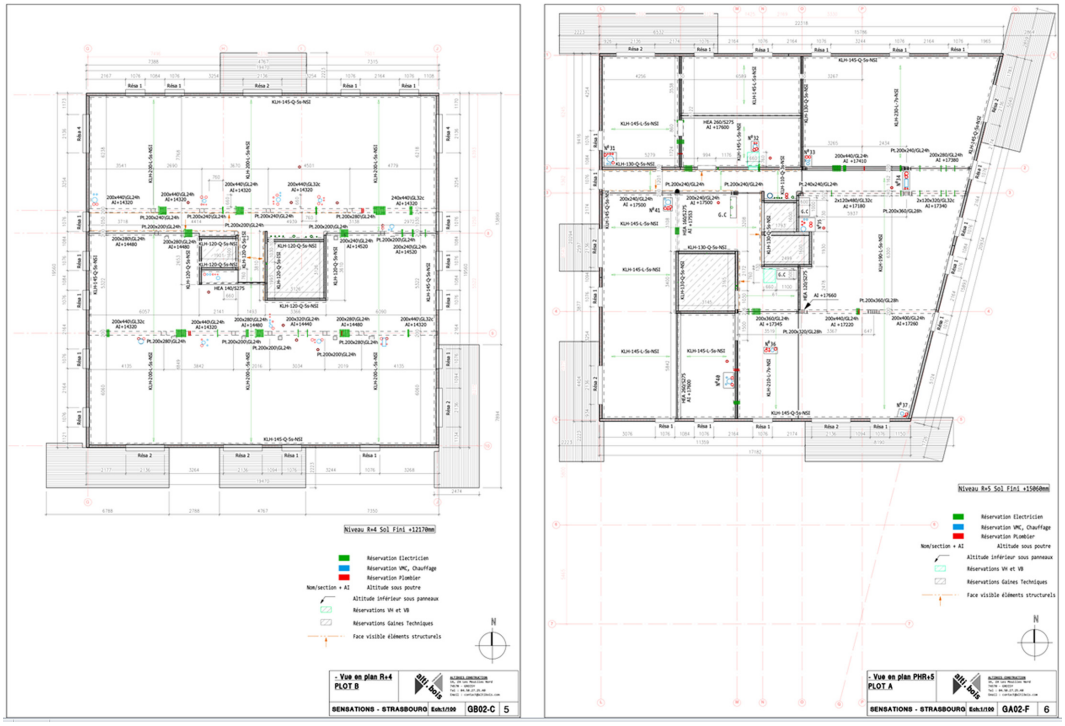


Figure 6. Structural plans.



Figure 8. Structures under construction.

			Requirements	Result
Summer comfort	**DH** *°C.h*	Hour-degree of discomfort (above 26-28°C)	1250	183
Energy	**Bbio** *points*	Bioclimatic needs	77,9	31,3
	Cep *kWhep/(m².year)*	Total primary (ep) operational energy for 5 uses	89,6	66
	Cep, nr *kWhep/(m².year)*	Non renewable primary operational energy for 5 uses	73,8	66
	IC énergie *Kg eq, CO2/m2*	50 year span Life Cycle Analysis of climate change impact by primary operational energy	2022-2024: 590,4	124,2
			2025-2027: 274,1	124,2
Carbon	**IC construction** *Kg eq, CO2/m2*	Life Cycle Analysis of climate change impact by building materials and construction works	2022-2024: 671,9	495,1
			2025-2027: 581,9	495,1
			2028-2030: 511,9	495,1
			2031- : 421,9	495,1

Figure 9. How Sensation meets the requirements of summer comfort, energy, and carbon.

issue of the metal connectors between walls and slabs: how would they react under the multidirectional and sudden stress of a quake? No one could answer that and the whole project froze for a while until the solution was found by the wood builders: revive a traditional craftsmanship technic, the "muralière". A simple beam that allows for a linear connection between walls and slabs. Building code considering it a "current technic", no need for a quantum



Figure 10. Sensation exterior and interior.

computer’s power to justify it! (Fig. 6-9).

3.6. Acoustics

More than fire, acoustics is the tricky part regarding wood in residential buildings. Having engineers with a large experience on CLT was an obvious necessity that played well. Lateral transmission between apartments, even with “light” gypsum board partitions as in our case is pretty classic. Vertical transmissions, of sound and impact, are taken care by a sound resilient between the the cement screed and the CLT panels, and insulation under it. So far so good but after handover one of the damned “low frequency leak” appeared between the top terraces and the apartment underneath. Fortunately the simple addition of a resilient under the support pedestals of the wood flooring solved it.

3.7. Carbon

From 2013 to 2018 the project saw a changing landscape in terms of regulation and voluntary certifications. In the original brief the requirements was to be **BEPAS**, an energy positive certification derived from the swiss **Minergie**. Sensations’s sloped crowning is inclined south to host photovoltaic panels that would have been paid for and maintained by an energy company, renting the roof and reselling electricity to all the “Ilot Bois” tenants. Unfortunately that was a too early move for existing business and it’s only recently at the Paris olympic village that we have been able to achieve that.

In the aftermath of the Paris COP21 in 2015 a new certification - **BBCA** for Low Carbon Building - was launched to challenge developers on building lifecycle carbon footprint. It was an obvious choice for Bouygues Immobilier to test it with Sensations and we attained the “excellence” level. Interestingly this certification has been a source for two other carbon impact assessments now in use. First is the new European **Low Carbon Building Initiative** “LCBI” currently gaining traction.

The second is the renewed French energy code for buildings, the **RE2020**. One of it’s particularities is to put thresholds for operational and embodied carbon, paving a way towards “net zero” by 2050 for the industry.

When it came into service in 2022 we decided to run Sensations through the required calculations.

As shown on the table, results were far better than expected, this 2014 project being able to meet all requirements almost till the last embodied carbon goal in 2031.

No doubt that the combination of a mid-rise compact form factor, massive wood structure with external insulation, sun shades, geothermal energy and hot/cold floors, help.

Wondering what prevented us of reaching the ultimate embodied carbon goal we discovered that two little changes could have brought us a breath from it.

Replacing the PVC roller blinds by metal or wood ones makes about 30% of the need effort.

But also recognizing the relativity of the values used. They come from the **INIES** French database on the climate impact of building material - running since 2004 and comprising about one third of the available data worldwide. In the database the same product can have three values: a default one given by authorities, a group one provided by an association of manufacturers, and an individual provided by a single manufacturer on his specific products. In our case, we took values available before 2018 to reflect what was the star of the art at the construction time. Replacing the default value for cement screeds incorporating the heating/cooling pipes by recent additions to the database by manufacturers brings another 40% gain on the result.

4. Conclusion

It is quite amazing to take this retrospective look on

Sensations, so much has happened since for mass timber mid and high rise buildings in France! But it is also the testimony to a moment when everything seemed possible. The rise of mass timber through such pilot projects has brought more expertise to all stakeholders, and restricted possibilities notably around fire regulations.

Nevertheless it is striking that all team members continued in this path: ASP handed last year a great project in Grenoble; Aida has become a reference in wood building acoustics; Bouygues Immobilier committed to a rise in mass timber projects; and with Eiffage we finished on time part of the Olympic Village for the Paris 2024 games.

What connects all these projects more than the technical feat is certainly how from to the creation of well tempered environments fitted for climate change, to the reduction of the carbon impact of buildings, it enhances the quality of life of people through the natural sensitivity and connection to nature that living in wood brings

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