

# PART 5

## REFLECTION

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### (TTE) TALL TIMBER EXTENSIONS

#### Conventional research vs conventional design methods

TTE, or Tall Timber Extension is a new research topic, and there are not many available sources for comparing the data. The research methodology tries to analyze several case studies for each of the subtopics, Tall residential buildings, Tall Timber structures, and Extensions on top of an existing buildings, in order to provide a complete canvas for the research. All of the three categories share something in common, the overall approach towards a sustainable building. However, integrated global approach towards a building is not a conventional research topic, probably because of the great number of parameters involved, or the great dependency on site/project specific constraints.

On the other hand, in design disciplines, it is highly common to focus on the overall building first, and reduce the perspective towards details later. Needless, to say, this difference in conventional research and conventional design methods was not foreseen at the beginning of the research project, and created some difficulties. On the other hand, literature review of several case studies was a very useful process to understand technical limitations and extracting structural guidelines for Tall Timber buildings and Structural Extensions.

#### Sustainable construction typology

Within the master track of Building Technology, the Sustainable Graduation Studio aims at developing new techniques that can make a sustainable contribution to the way we construct our buildings. Tall Timber Extensions, addresses the mentioned questions in three combined ways. Tall Buildings (alternative architectural solution for crowded cities) Timber Buildings (alternative sustainable structural material) Extensions (alternative construction method in order to avoid demolition and preserve existing buildings). At the same time, these three parts share sustainability in building structures as the main common line.

#### Difficulty for fully-integrated building approach

In my opinion, overall building studies are a great necessity nowadays. Traditionally, cathedrals were designed and built under the guidance of the only one person, that was able to control design disciplines, construction techniques, logistics, etc. That person was known as "the great master", take Antonio Gaudí as an example. Today, with a growing specialisation in construction, this integrated vision has been lost, and building are subdivided in an endless list of disciplines, façade, structure, climate, computational, architecture, project management, glass specialist, timber specialist, infographies, BIM, sustainable specialist, etc.

However, at the interfaces between disciplines there are usually conflicts that usually result in less architectural quality of the building. This issue is constantly ignored in conventional research methods, that constraint building complexity into a few parameters to be researched, and do not consider the riches of an integrated approach. In every building a myriad of important issues are interconnected, and it is not a simple task to separate them and ignore the implications on other requirements. For example, client demands, site-specific constraints, architect ambitions, technical limitations use different research methodologies, but in practice they should be smoothly combined into a high-quality architectural object.

#### Designing is an intuitive (re)search for the unknown

It is a common saying, that researching is looking for something you do not know. Designing is an intuitive and personal process, that is demonstrated through consecutive design iterations. It may have a less strict methodology, but this does not mean that it is not research, or that is is illogical.

In the graduation studio, the suggested methodology was based on academic research, which draws first a clear route and heads towards the planned objective. Personally, I found it very difficult to create a good design with this methodology, as every decision has to be planned in advance and "proved" with logical arguments. Coming back to Gaudí, his research method was experimenting with shapes and concepts, by creating physical models and drawings and iteratively testing architectural expression and structural efficiency.

Designing is experimenting, it is working hard, and develop your own individual methodologies, and allowing flexibility in the process. It is often the case, that best designs come when you do not know the outcome. In conclusion, it is an intuitive exploration of your design intentions through different formats. This process, even though, sometimes may not follow a step-by-step approach, it helps in creating innovative research, as it is able to connect different topics that can make the difference.

For example, Gaudí connections between nature-like shapes and form-finding can be very difficult to achieve with academic research methodologies. In conclusion, academic research can provide solid grounds and rational results that can be suitable for structural design. However, more intuitive design methods can provide an interesting alternative for architecture concepts.

## 15. FURTHER RESEARCH

### Acoustic properties

Floor systems in tall buildings are not only subjected to structural requirements, they should also meet enough sound insulation between floors. Nevertheless, acoustic behaviour of a given construction system is not a straightforward answer. A comparison between single-leaf constructions such as CLT panels, with cavity constructions such as Lignatur floor system, with concrete hollow core. Concluding in an optimisation of structural performance meeting sound insulations requirements for multi-storey buildings.

### Composite action

Preliminary methods for analysing composite action between different interlayers of CLT panels, and concrete, providing simple rule of thumbs and criterias for the use of engineers and architect in the design a custom made CLT or CLT-Concrete construction.

### Timber beams types for floor systems

It is not in the scope of this study to compare, different options for timber beams built up, Laminated Veneer, Glue laminated Timber, Parallel Strand Timber, etc.... A preliminary indication will be given, regarding the combination of glued laminated beams, with 100 mm concrete slab, for acoustic insulation with an approximate mass/surface of 250 kg/m<sup>2</sup>. Further research must be performed in order to evaluate shrinkage/swelling of the timber elements, composite action between layers, and shear connection between concrete slab and timber beams.

### Shrinkage and swelling

Timber can expand and decrease its volume depending on the surrounding moisture. When there high humidity, internal microcells inside wood get filled with water and consequently swell. Moreover due to the anisotropy of the material, these movements are higher in the transverse direction of the fibres, in the order of 20:1, compared to the longitudinal direction. These changes in dimensions need to be considered in the buildups of the floor systems and in the construction details.

### Behaviour in fire

Behaviour of composite cross-sections in case of fire

Large void spaces, concealed spaces on mass timber structures.

Structural adhesives in CLT panels leading to delamination of CLT panel layers

### Creep and differential shortening between concrete and timber