POLITECNICO DI TORINO

Honors thesis

COURSE OF

ARCHITECTURE CONSTRUCTION CITY

Abstract

Timber and durability.

Study and project of constructive details for

wooden frame and cross laminated timber (CLT) system.

Tutor

Davide Maria Giachino

by

Paolo Ferrero

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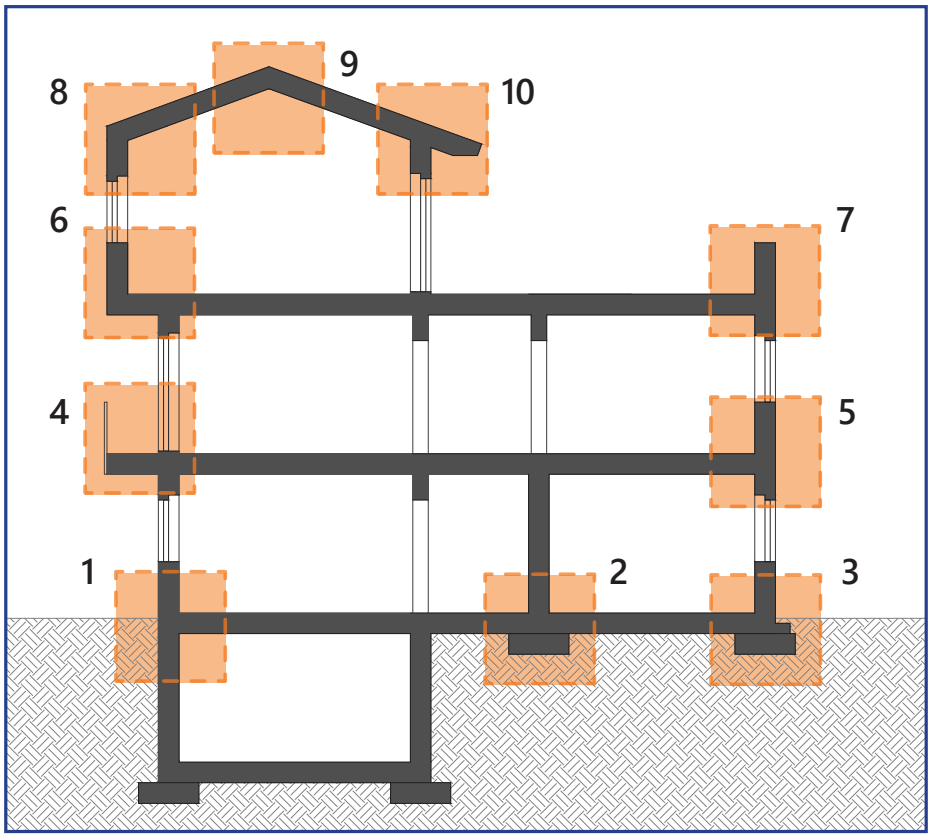
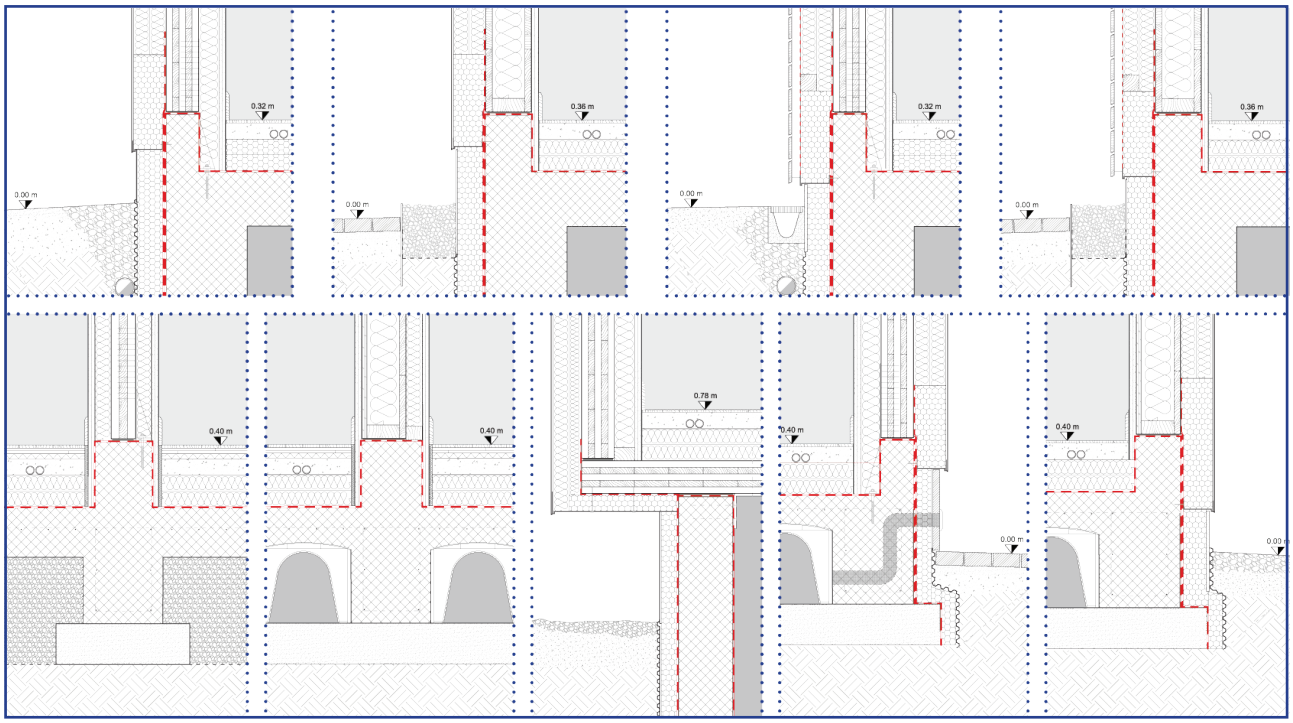
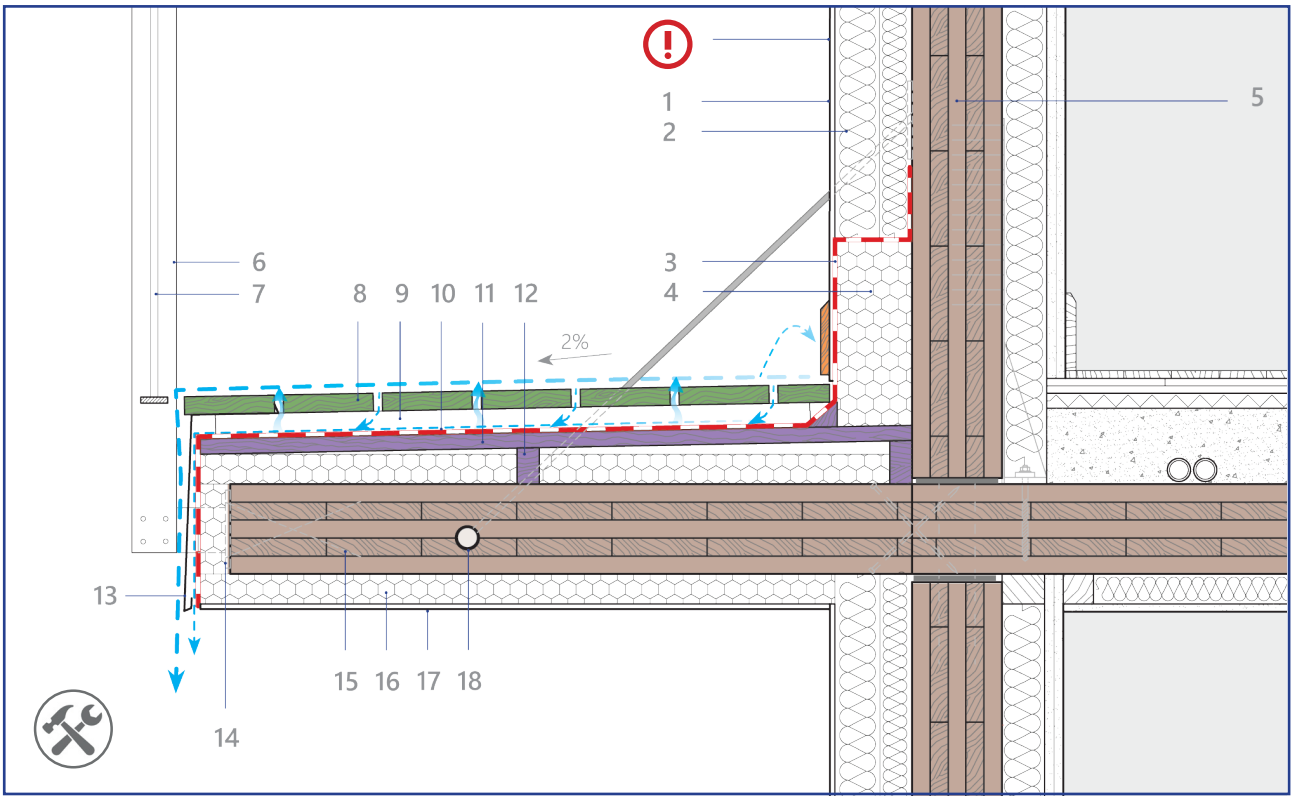
Over the past decade, the "rediscovery of the use of wood in architecture" has been observed as an advantageous alternative and in some cases more sustainable of the most widespread construction technologies. Not just a reintroduction of old technologies, but it is the development of the potential of high-level innovation products and systems.
Since 2005, the market data of timber construction in Italy reported an increase in contrast to the construction industry stagnation. With the rising in the number of buildings, on the other hand, claims increased. More than 40% of these are caused by design and execution errors following approximate or from other building systems building-up theory and methods. Lack of knowledge and norms of right designing and building with wood, found at all levels, which motivated the writing of the thesis.
In fact, the main objectives were the critical examination on durability of the wood, the overcoming of prejudices and obsolete imaginary linked to wooden constructions and the development of a series of design proposals for constructive details for the durability of the wooden frame and cross laminated timber (CLT) system, with particular attention to multi-storey buildings. Therefore, it was sought to understand limits and potentials of using timber in architecture, transforming a "trend of the moment" into a well-founded "project culture".
The followed methodological approach provides cross-sectoral research, comparison with industry experts, analysis of existing legislation at national and European level, and several inspections in different construction site.
The work has been divided into a first part of research and a second of project. The thesis provided information on the history of wooden constructions, analysis of the main wooden constructive systems and wood-based products used in architecture, descriptions of the state of the art, illustrations of the regulation framework, biotic (lignivorous fungi, xylophages insects and marine organisms) and abiotic (anthropic, weathering, delamination and contact with metal elements) analysis of wood degradation and research of its durability within the architectural design. A specific study was made for the cross laminated timber, a recent massive engineered construction system. Noting differences in composition, size and structural strength between these panels, was included a comparison between the first twelve European producers and the major six Italian producers.
Following case studies analysis, cataloguing of multiple design, execution and maintenance errors and the statistical analysis of damage of wooden buildings, was developed the design of constructive nodes. This project, complying with the principles of moisture design and the requirements of static and living comfort, has developed ten main constructive nodes of a hypothetical architectural section, and then more than thirty variants in scale 1:10.
A series of solutions conceived as examples of good design and good construction with the two main wooden structural systems used in Italy and Europe: wooden frame and clt, including the types of external wall insulation system (coating) and ventilated wall.
Each element of the nodes were graphically characterized by a different level of temporal durability and, in cases of reduced or compromised durability, has been proposed a system of removable and replaceable elements too.
At last, it has been shown that the design of wood durability in architecture derive from closely related design phases, the adoption of design precautions (both for the complex initial morphological approach and the enclosure system), the conscious design of construction nodes and details and the ordinary maintenance project.



Img. 1: Architectural typological section for the study of constructive details.



Img. 2: Group of constructive nodes designed for the ground connection of the building.



Legend Img. 3:

1. External plaster
2. Double layer of organic insulation (wood fiber or wood wool)
3. Waterproof membrane
4. Synthetic insulating layer (eps / xps / cellular glass)
5. Spruce Cross Laminated Timber panel,with five layers
6. Steel railing mast, anchored to the CLT panel through a bolted plate
7. Metal railing
8. Larch slab floor, with 2% minimum slope
9. Uplift larch bar and floor support
10. Waterproof membrane
11. Slope panel, OSB cat.3
12. Lath of larch for the sloping
13. Shaped metallic sheet
14. Mechanical railing anchorage system
15. Spruce CLT panel, with five layers
16. Synthetic insulating layer (eps / xps / cellular glass)
17. External plaster system
18. Anchor for the tie rod

Durability ≥ 50 years
Durability > 25 years
20 y < Durability ≤ 25 y
10 y ≤ Durability ≤ 20 y

Meteor rainfall

Drying and evaporation of rain water and humidity

Removable and replaceable items

Protective elements of the wood structure with lower durability

Img. 3: Example of constructive node designed for a balcony with clt structure.

For further information please contact:
Paolo Ferrero, paoloferrero.post@gmail.com