# Future challenges and need for research in timber engineering

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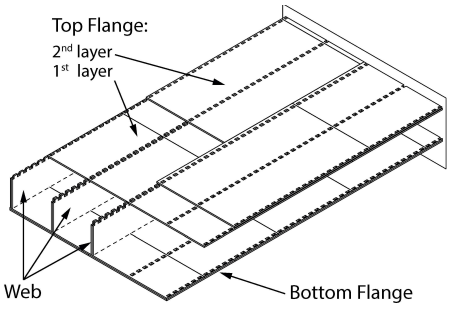
## Abstract

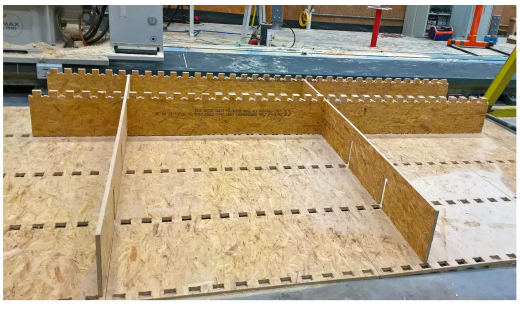
Automation is increasingly present in the construction industry, whether at the design, manufacturing or assembly stage. Thanks to new technologies, such as robotics, new ways of designing structural elements can be imagined and implemented. Complex methods and sequences of assembly can be set up quickly as well. Numerous studies have been carried out in this direction at the laboratory for timber constructions IBOIS (EPFL) especially on wood-wood connections called Integral Mechanical Attachments (IMA). IMA for structural timber elements offer an alternative to structural bonding. Fabrication process and geometries are more flexible and can be used to design others timber construction products which is a great advantage for medium size timber companies. Moreover, there is no need of a drastic quality control compared to bonding process. At the beginning these connections were implemented on folded plate structures and more recently on double-layered timber plate shell which are particularly specific geometries.

Gained from these knowledge, the work performed at IBOIS is now more focused on the development of standard prefabricated structural elements (roof or slab, see figure below) using IMA in order to bring this technique into common practice for architecture and engineering. The behavior of these connections will be investigated and optimized for different engineered wood products. Experimental tests and numerical models will be developed to determine the mechanical response of these timber elements in order to satisfy or develop the current standards for timber engineering. One of the future challenges will be to summarize and deepen the knowledge on wood-wood connections especially IMA which can be produced easily with digital fabrication.

For timber construction there is only literature for assessing the semi rigidity of mechanical fasteners. The introduction of mechanical fastener stiffness, called $K_{ser}$, was a major advance in Eurocode 5 in order to solve problems of stability and large displacement which is usually the most critical point for timber structures (Serviceability Limit State). Therefore, in order to bring these techniques into common practice, there are gaps to fill concerning the behavior of IMA connections:

- Slip modulus called $K_{ser}$ (stiffness)
- Failure modes
- Resistant capacity
- Long terme behavior



## Ongoing and planned activities at IBOIS

### Research

IBOIS research are focused on the development and integration of digital technologies within the field of architecture especially timber construction as the laboratory is part of the National Centre of Competence in Research (NCCR) for Digital Fabrication. Ongoing research:

- Mechanical characterization for prefabricated timber elements using wood-wood connections Link
- Robotic assembly of prefabricated timber elements using wood-wood connections
- Semi-rigid moment-resisting behavior of multiple tab-and-slot joint for timber plate structures Link
- Mechanical Characterization of integrally-attached timber plate structures using Macro Models Link
- Local usage of round or sawn timber for both free-form and traditional structures thanks to digital fabrication Link

### Projects

A growing interest from timber industries in these connections has emerged and various projects have been realized which prove the feasibility of this type of construction. Ongoing and completed projects:

- The new timber pavillon of the Vidy theatre Link
- Multipurpose hall in Manternach Link
- Industrial hall in Belgium using prefabricated timber elements
- Grand Chalet train station Link

The new timber pavillon of the Vidy theatre (photo credit: Ilka Kramer)