Interreg North-West Europe
Adhesive-Free Timber Buildings
European Regional Development Fund

Technical Note 8
Numerical Modelling

One of a series of short briefings on timber technology produced by the towards Adhesive-Free Timber Buildings (AFTB) research project. The project is co-funded by Interreg NWE, 2016-2020. This note explains briefly the theory on which the implementation of the numerical modelling is based. It also states why this tool is important and who and for what it is aimed at.

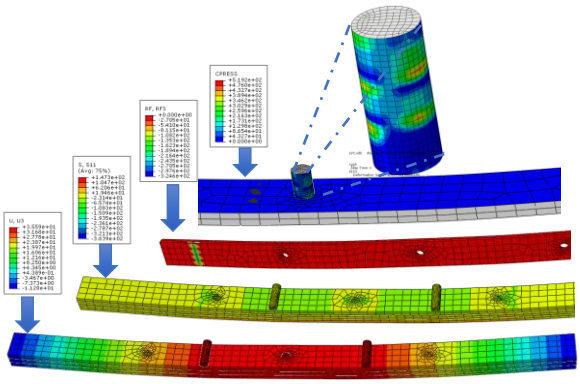
How can you perform destructive tests on wood beams without destroying anything?

Simulation

To experimentally determine the flexural properties of beams or panels, bending tests are used. In the lab, timber structures are placed in testing machines between loads and support rollers. Then the load is applied progressively until the failure of the structure. Such study is time consuming and expensive since it necessitates many samples to ensure statistical validity. Moreover, each time a new geometry is designed, new tests are required. Unlike metals, polymers, or ceramics, wood is a natural material with highly orthotropic properties. Simply put, timber is far stiffer and stronger when loaded in the longitudinal axis (normal to the growth of the tree) than in the radial or tangential axes. The strength of wood is also influenced by factors, including wood species, moisture content and temperature.

Following compression at elevated temperature the mechanical properties can be significantly improved *(see technical note 3)*. Our project investigates the use of compressed wood (CW) dowels instead of traditional adhesives and metallic fasteners to assemble structural timber elements *(see technical note 4)*. The size of these CW dowels and their distribution patterns are relevant parameters influencing the element stiffness and load-carrying capacities.

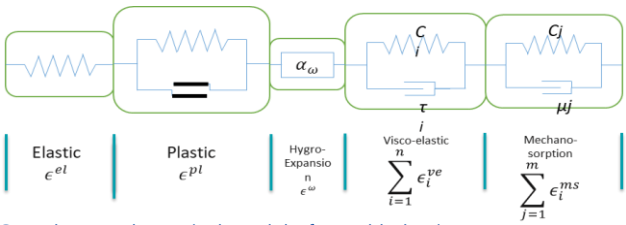
Thanks to numerical simulation tools, it makes it possible to have a real idea of structure behaviour but more importantly, to run tests of many different design options.



Simulation and analysis of a bending test on adhesive free beam

Mathematical model of densified wood

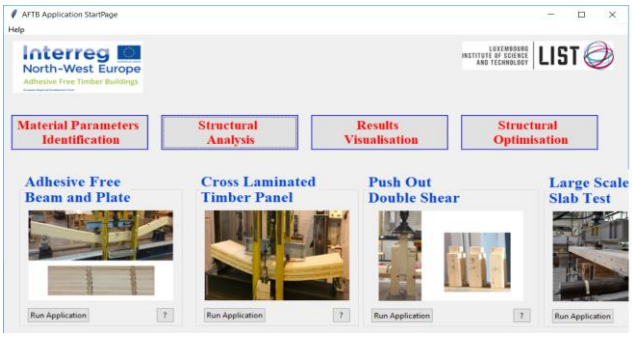
When subjected to hygro-thermo-mechanical loadings, the wood response includes a combination of the following deformation modes: elastic deformation, plastic deformation, hygro-expansion (swelling or shrinkage), viscoelastic creep and mechano-sorption as shown by the following scheme.



Complete mathematical model of wood behaviour

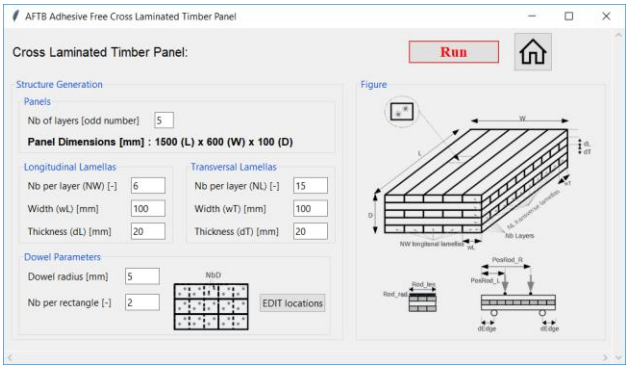
Structural Design Tool

In order to design complex structures and perform mechanical analyses using finite element method, the *Luxembourg Institute of Science and Technology (LIST)* developed an advanced structural design tool. It is conceived as a user-friendly interface to determine wood properties (from simple physical experiments) and to generate dowelled wood structures. Standard tests such as three-point bending or four-point bending tests, push out double shear tests… etc may be simulated.



Structural Design Tool main page

Complex geometries including cross-laminated timber panels (CLT), multi-layered beams or joints, all assembled by compressed wood dowels, can be generated readily and simulated. Users can modify the geometry by choosing the number and the size of lamellas and define a pattern for the dowels.



User Interface to design cross laminated timber panel

This tool is linked to the finite element software *Abaqus CAE* to conduct simulations and analysis using the custom mathematical model developed by LIST. The generate geometries may also be exported for use by the user in other software.

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Stakeholders Welcome

A key aim of the project is to engage with businesses, regulators and other interested parties. Adhesive-free timber building technology could be of interest to your business. Please get in touch via the e-mail addresses below:

For more information please visit the Adhesive Free Timber Buildings (AFTB) project website http://www.nweurope.eu/AFTB or use the contacts.

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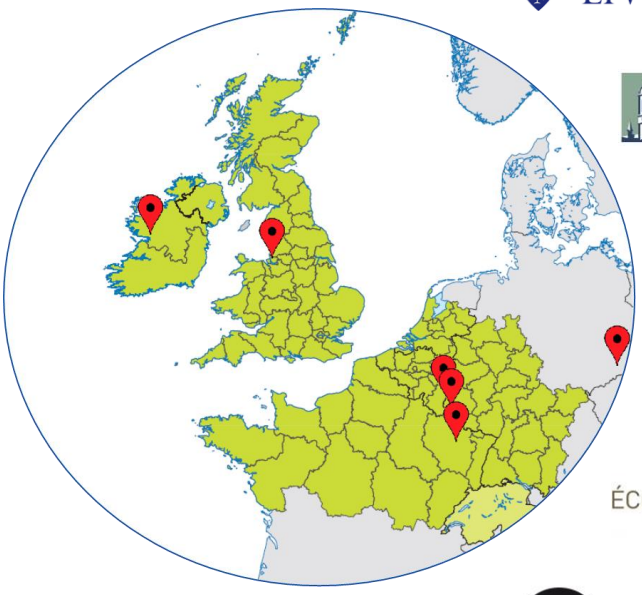

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