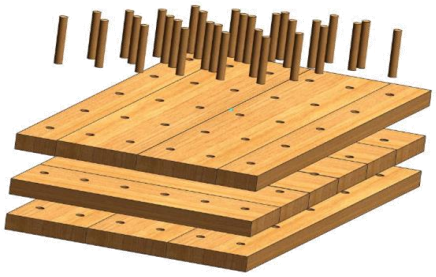
Interreg North-West Europe
Adhesive Free Timber Buildings
European Regional Development Fund

Fully Sustainable, Natural Engineered Wood Products Using Compressed Softwood Dowels


Left to right: dowel connected EWP, schematic of assembly, double curved EWP roof structure at Royal Holloway University, UK (image courtesy of Buckland Timber, UK)

Regulatory and customer pressure is driving an increasing need for sustainability in the construction sector. Replacing the glue in laminated timber products offers a route to this goal. The Towards Adhesive Free Timber Buildings project seeks to deliver this vision.

Five million m^3 of engineered wood products (EWPs) are produced in the EU annually and the market is growing as EWPs provide a 'green' alternative to steel and concrete. Despite the many benefits of EWPs, they have some drawbacks. EWPs have a high degree of petrochemical use in their manufacturing. In general, the production of one cubic meter of glulam timber requires 5kg of phenol-resorcinol-formaldehyde (PRF) and 1kg of melamine-urea formaldehyde (MUF). While the greatest environmental impact of these adhesives is during manufacture, their presence may significantly hinder the recycling/reuse potential of EWPs. Timber buildings are normally constructed using EWPs connected using steel connectors. Changing from steel to wood-based connection systems will enhance their environmental performance.

To address this, a consortium with members from six European countries was formed to develop adhesive-free EWPs through a joint project supported by the Interreg NWE, a program of the European Union.

The project will:

- manufacture thousands of compressed wood dowels. The dowels are produced from pre-dried timber using a pressure of 200 ton/m^2 at elevated temperatures. Various species native to north west Europe will be trialled;
- test the dowels individually before using them in the assembly of EWPs: CLT, beams and beam-beam connectors. These will then be tested and benchmarked against traditional glue-laminated products. Tests will include a full structural assessment as well as testing for fire resistance;
- employ numerical simulation via Finite Element analysis to guide the testing process and validate conclusions;
- construct three demonstrator structures in Dresden, Germany, Epinal, France and Liverpool, UK. These structures will rely on adhesive-free EWPs for their structure and will deliver a real world proof of the concept. Visits will be arranged for interested parties to see the products in use.

Traditional dowel-connected timber-framed building, England, left and modern timber techniques in the Japanese Pavilion at Hannover Expo (right). Photo credits: Doug Elliot, Jean-Pierre Dalbéra.

Background and Advantages

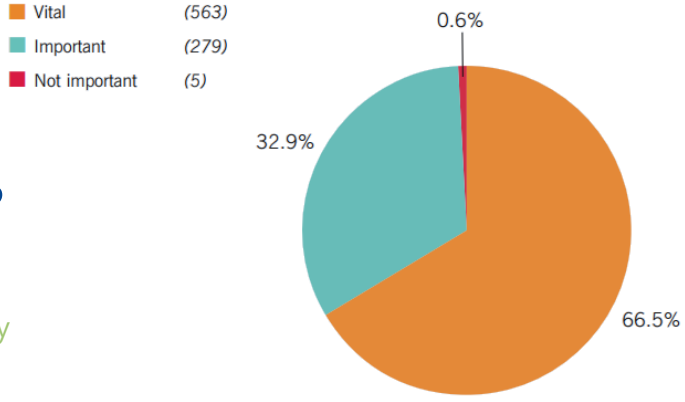
Hardwood dowels have been successfully used to connect elements in timber frames for thousands of years. Unfortunately, these connections suffer from creepage and a loss of stiffness over time, which can lead to unacceptable displacements within the structure. This can be accepted for small structures but prohibits using the technology for large, multi-storey projects. Dowels made from compressed wood, their density increased by up to 68%, spring back towards their original shape over time, thus maintaining pressure within the connection. This retention of stiffness and form should allow the technology to be used far more widely.

Currently, such buildings where timber is used utilise glue laminated timber connected with steel brackets. Compressed dowel construction eliminates the risk of corrosion and metal-mediated heat loss, while significantly reducing the total carbon impact of the structure. For specialist users such as hospitals and universities, eliminating the steel connectors also allows use in high magnetic field environments. The EWPs can also be modified and finished on-site using basic carpentry skills, allowing for a more flexible approach to construction.

At the end of a structure's life decommissioning and disposal costs can also be reduced by the use of adhesive-free EWPs. It is envisaged that these structures can be disposed of as the lowest category of wood waste, suitable for reuse or as fuel for power generation or heating. Reducing the volume of construction waste sent to landfill is also a key sustainability priority.

How important is sustainability for the construction industry?

Survey for "The Green Perspective, a UK construction industry report on sustainability" by the Chartered Institute of Building, UK

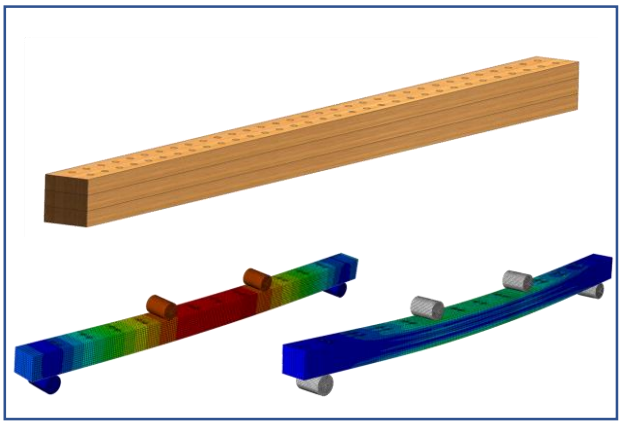


Testing and modelling

The partners are comparing the properties of compressed wood dowels to traditional hardwood dowels in bending, tension, compression and shear. The embedment of the dowels in timber laminates will also be compared.

CLT, grid, beam and connector structures will then be compared to equivalent glued EWPs produced commercially, via destructive four-point bending tests.

Over the course of the project over 600 individual tests will be performed providing a body of evidence to accelerate the adoption of this technology.



Finite element model showing exaggerated displacement of dowel laminated timber under loading, University of Liverpool

Numerical modelling, led by the Luxemburg Institute of Science and Technology will be used to optimise the EWP design and to extract generally applicable information from the testing program.

Demonstrator Structures

In order to prove the real world applicability of the adhesive-free construction techniques the consortium will build three demonstrator structures:

- a garden office in Ness Botanic Gardens, near Liverpool, UK
- a portal frame demonstrator structure with roof, at the Wood Campus of the University of Lorraine, Epinal, France
- a third structure will be developed in Dresden, Germany

These structures will allow partners to gather data on how the compressed dowels perform over time and provide for engagement with prospective users and the wider public.

Ness botanic gardens, near Liverpool UK, the location for one of the three adhesive free timber buildings demonstrator structures, http://www.nessgardens.org.uk

Stakeholders Welcome

A key aim of the project is to engage with businesses, regulators and other interested parties. If you believe adhesive free-timber building technology could be of interest to your business please get in touch via the email addresses below.

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The Towards Adhesive Free Timber Buildings (AFTB) project is an inter-regional project with collaboration between six European institutions. The project is funded by the European Regional Development Fund (ERDF) via the Interreg NWE Program.

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