Ty Unnos - a house in one night

As part of TRADA's 75th Anniversary competition, Coed Cymru won TRADA funding to further develop the Ty Unnos project and demonstrate to industry the benefits of innovative design and locally sourced materials. The particular objective of the award was to pay for TRADA to conduct a rigorous assessment leading to a European Technical Approval (ETA) for the building system. Design Engineer Ramona Stoicescu was closely involved with the research.

A house in one night

Ty Unnos or "House in One Night", represents the result of an extensive research programme developed by Coed Cymru, a Welsh not for profit public sector partnership, in collaboration with the Welsh School of Architecture, Cardiff and the University of Bangor. Funding for the feasibility study was provided by the Countryside Council for Wales, the Forestry Commission and the Environment Agency. Technology Strategy Board and the industrial partners (Pontrilas Timber Ltd, Kenton Jones and Blaenau Gwent CBC) funded the development of the system.

The tradition of Ty Unnos is strongly rooted in Welsh folklore whereby if a family could build a house within a night, from dusk to dawn, and have a fire burning in the hearth, the house and the land became theirs. Although there is no legal basis to the tradition, it was very common practice and many survive. The name was chosen to reflect the use of local materials, self reliance and initiative.

The project was initiated by Coed Cymru from the need to create high performance affordable housing in Wales while addressing the aspiration to promote the use of Welsh grown timber in construction.

TRADA's 75th anniversary funding complemented funding from various other sources. Together this gave the research partners the opportunity to continue their work in the utilisation of locally sourced timber, so encouraging the Welsh timber industry to become more innovative in the use of timber and timber products. The TRADA funding supported the technical assessment, while the Aggregates Levy and the Pembrokeshire SDF paid for the testing programme.

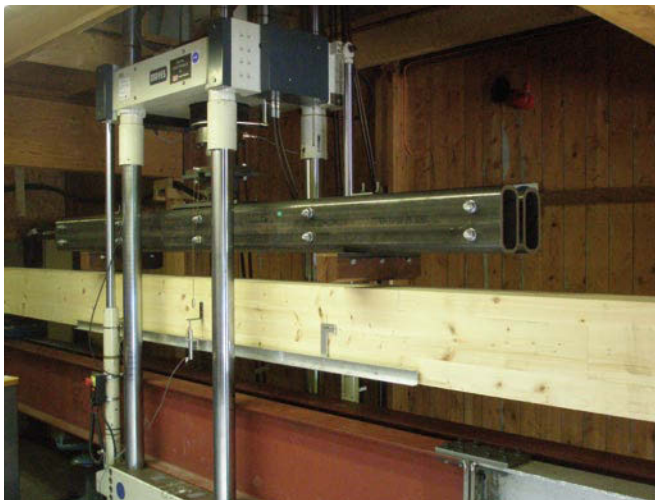
Ty Unnos – a very versatile system suitable for volumetric or on site assembly - is the result of an extensive research programme based on the use of Welsh grown Sitka Spruce and other softwoods to produce structurally sound members which can be assembled to create a timber frame building system.

Shortly after the publication of the feasibility study, Elements Europe Ltd approached the research partners specifically to develop the volumetric system which is now available as Ty Unnos Modular.

In comparison with Scandinavian and Baltic softwood of the same species, home-grown timber is of a lower strength class. To make the most of the available strength of home grown timber, the structural elements of the system were designed from innovative components, namely of glued box beams and ladder beams.

The structural members of the Ty Unnos system were produced by a log conversion method that provided the optimum timber board sizes with the minimum distortion possible upon drying. The remaining material was processed further for other structural elements. This method produced the "maximum utilisation of logs with a minimum waste impact", as explained by David Jenkins of Coed Cymru.

The structural design was undertaken to Eurocode 5 and associated standards, although sometimes it was necessary to return to basic structural principles for components that are not specifically covered by the code. For example, the design of the box beams followed the same approach as is commonly used for I-beams, by considering the box sides as a thick web and the upper and lower faces as the flanges.



Shows a 4-point bending test showing the setup as used for bending stiffness and strength.

Shows the 4-point bending test setup used with Ty Unnos ladder beams.

The design of the ladder beams proved to be more difficult, as it was too complex to be justified by calculation due to the solid timber "rungs" acting as a discontinuous web. Consequently the design of ladder beams involved a series of development tests followed by a large number of tests on the final design to establish the load-bearing capacities.

These two main structural components form the principal elements used to assemble the system. The box beams form a rigid frame with specially designed node connections, while the ladder beams are used with shear diaphragms for the floors and walls.

The floor and wall components provide horizontal and racking stability to each module. When modules are stacked to create multi-storey buildings, the shear resistance is transferred through connections between the frames.

Being such an innovative system, the calculation model provided as the theoretical basis for the structural design was verified by a testing programme to confirm the mechanical performance of individual components.

To this end, a number of tests were performed by TRADA Technology at its laboratories and its partner testing facilities. These tests included a series of bending stiffness and strength tests both on the box beams and the ladder beams, rotational strength and slip tests of joint connections, racking strength tests of several panel variations and fire tests on typical floor/ceiling and wall arrangements.

The bending strength and stiffness tests carried out on box beams and ladder beams provided the confidence that the material design values were safe. The initial tests exposed any weaknesses in design and fabrication that led to important improvements for the final versions. The improvements did not involve major changes, but demonstrated the importance of getting the details right.

The connectors used at the nodes where the box beams meet to form the frames are designed to transfer rotational forces so that the frames do not twist out of shape. These connectors were subjected to rotational tests which showed that the strength was lower than predicted, since the mode of failure was not as expected. However, there was sufficient strength in the connectors to derive safe design values that were applied to the design model.

The racking resistance test programme, developed under TRADA's supervision, was undertaken on a range of panel variations to which combinations of vertical and horizontal loads were applied. The racking tests were used to verify the racking resistance derived by calculation in accordance with Method A of EC5. The performance in test was comparable to the capacity derived by calculation, once factors relevant to the calculation method were considered.

To comply with Building Regulations, standard fire tests on typical floor/ceiling and wall arrangements were performed. Although Ty Unnos relies primarily on the fire resistance of the plasterboard lining, in common with most timber frame buildings, tests were necessary because the box beams and ladder beams are an innovative method of supporting the lining. The fire tests demonstrated the integrity of the floor/wall arrangements as designed for use in the Ty Unnos system, and also revealed the important role the insulation played in protecting the unexposed internal surfaces.