SWEET SUCCESS

George Fereday, *senior lecturer and technology co-ordinator at the CASS School of Architecture, London Metropolitan University explains how design can be used as a tool to promote home-grown species*

Above: Students prototyped, tested and built a range of spatial timber structures

The UK currently imports 82% of all wood used and this has a negative effect on UK forestry, with only 59% of our woodlands in active forest management. Of the hardwood we harvest in the UK, 76% is burnt as fuel.

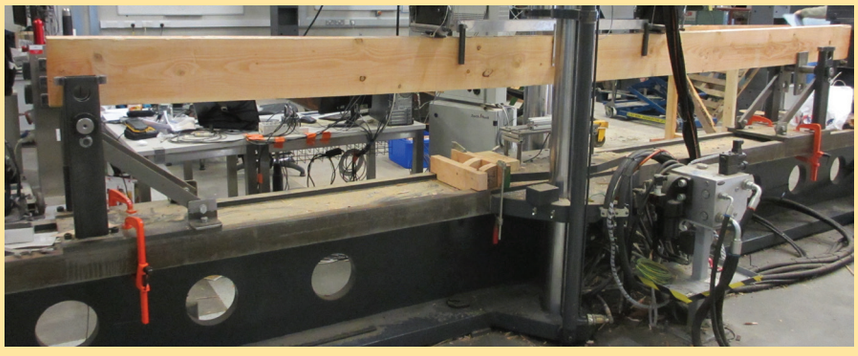
Noble species including oak, ash, beech and sweet chestnut have been used throughout the UK for construction because the timber provides excellent mechanical strength, stiffness and, when detailed correctly, long lasting durability. The onus is on designers and suppliers of UK-grown timber to demonstrate value-added uses for these excellent materials and well before the point at which it's burnt for energy.

As demonstrated by a number of landmark buildings in the UK, it is possible to promote a culture of 'local materials first' that can ensure elevated use of the UK's diverse timber resources whilst bringing many positive changes to society:

- sustainable growth of rural economies through widespread forestry, processing and distribution;
- greater bio-diversity in our woodlands through active forest management and a higher amenity value associated with our woodlands;
- much needed afforestation of the UK as part of a sustainable economy;
- low embodied energy, high carbon storage

GRADING DOUGLAS FIR

Research into machine grading Douglas fir is aimed at making more species available for the Irish and British construction markets. ***David Gil-Moreno*** *(NUIG),* ***Dan Ridley-Ellis*** *(ENU),* ***Conan O'Ceallaigh*** *and* ***Annette M Harte*** *(both NUIG), report*



Above: Four-point bending test of a specimen of 76x225mm² section

The importance of Sitka spruce to forestry in Ireland and the UK is widely known. For a long time, it has been the only species strength graded in Ireland, either visually or by machine. In the UK, it has also been possible to machine grade larch with modern grading machines since 2014. Machine settings for larch and Scots pine with bending type Cook Bolinders and Computermatic/ Micromatic machines were available since before this time, but are of less importance to modern sawmills.

UK-grown Douglas fir can be visually graded, but the opportunity of commercialising the large material supply becoming available in the near future requires the possibility of using machine strength grading for its higher speed, improved yields, and wider range of possible strength classes.

Incorporating a new species into the market allows more choice for customers, and a product that may be better suited to particular

timber buildings that are better for our physical and mental well-being.

To test the validity of these ideas and to act as a case study for positive change, our students at the Cass school of architecture experimented with hand-cleft sweet chestnut, exploring how this species might be 'specified-in' to the built environment through a creative design process.

As part of a four-day making workshop, the students prototyped, tested and built a range of spatial timber structures using a hybrid combination of graded imported and un-graded domestically grown timber. Chords of trusses were of imported softwood and the connecting web members of local cleft sweet chestnut. The resulting structures were lightweight, fast to make, cheap, structurally viable, and made, in part, from materials grown one hour from the building site.

Sweet chestnut was chosen as an under-used, durable timber with a high degree of naturally occurring anti-fungal extractives. When coppiced as part of a well managed woodland, 'stools' of multiple stems of straight growth are promoted and harvest cycles can be two to three times higher than that of other fast growing UK tree species such as Sitka spruce, depending on the diameter of roundwood required. Once harvested, chestnut stools naturally regenerate, unlike clear-felled or extracted trees, which require re-planting. This cycle of growth and harvest can repeat indefinitely with some of the oldest trees in the UK, coppice stools.

Once de-barked, harvested sweet chestnut roundwood exhibits very little sapwood and when hand-cleft into the small diameter lengths that we used for our workshop, is a zero-waste process. Cleaving the timbers apart also leaves the wood's cellular structure largely intact, making for a more durable timber surface.

Cleaved wood also taps into existing rural industries such as the flourishing supply chain in sweet chestnut fencing. This is an example of a sustainable, growth industry that provides, local, healthy, well-paid and highly skilled rural jobs that are good for local biodiversity. Coppicing can also contribute towards the mitigation of climate change. Recent studies in Europe have found that coppicing practices with sweet chestnut can increase the volume and rate of sequestered carbon from the atmosphere whilst simultaneously providing viable timber for long-term applications like construction.

To ensure though that 'non-standard' timber is readily available on the market and safe to use as part of a building structure, we need grading standards that are better representative of the full range of characteristic properties that abound between timber species and even between trees of the same species grown in different conditions.

In some cases this may mean batch assessing local timber in a non-harmonised manner. In our application of sweet chestnut as web members spanning between chords of a truss, this would mean identifying upper and lower longitudinal density ranges for these components so that a structural engineer can be confident of the mean structural properties of each truss and apply a suitable factor of safety to their calculations.

Whilst 'non-standard' this is well within the capabilities of the industry, as demonstrated by a range of innovative buildings made using local timber in the UK including; the UEA Enterprise Centre, the Flimwell Wood Enterprise Centre or the woodland campus buildings of Hooke Park in Dorset.

Let's not forget too that there are many thousands of medieval timber buildings still standing safely in the UK made from local material that were built using nothing more than an intuitive understanding of wood and an intelligent use of its properties.

Extracts from the piece are under review for publication by the *International Wood Products Journal.* ■

applications. As well as the better mechanical performance and appearance, the slightly higher natural durability of Douglas fir, compared to Sitka spruce, can play a key role in certain end uses.

WoodProps is a joint research programme between the Timber Engineering Research Group at the National University of Ireland Galway (NUIG) and the Centre for Wood Science and Technology Edinburgh Napier University (ENU) and is funded by the Irish Department of Agriculture Food and the Marine.

As part of this programme, WoodProps researchers are undertaking characterisation of the timber properties of minor conifer species as limited data is currently available. In April 2018, grading settings for 13 machines were approved for grading Douglas fir grown in Ireland and the UK. Different settings were developed for different grading machines: Goldeneye 706, Goldeneye 702, Viscan Compact, Viscan Plus, Viscan, Viscan portable (with and without balance), MTG 960, mtgBATCH 962, mtgBATCH 966, MTG 920, mtgBATCH 922 and mtgBATCH 926.

The material was sourced from Co Wicklow and Co Galway in Ireland and from Scotland and Wales. Nine sites were sampled, ages between 40 and 58 years old, giving a total of 704 pieces that were tested for bending modulus of elasticity, bending strength and density according to the European standards. Cross-section sizes ranged from 37mm x 75mm up to 76mm x 225mm. Particular focus was given to ~50mm x ~100mm size as this represents the most common structural size produced by sawmills in both countries.

Large differences were found between sub samples, but it is believed that this is not a geographical difference between Ireland and the UK, but between stands at more local level due to forest management and site conditions. The characteristic values per sub sample ranged from about 8.4 – 13.4 kN/mm^2 for modulus of elasticity (mean) with an overall value for the full dataset of 10.6 kN/mm^2, from 12 - 29 N/mm^2 for bending strength (5th percentile) with an overall value of 15 N/mm^2, and from about 360–480 kg/m^3 for density (5th percentile) with an overall value of 395 kg/m^3.

The basic grade of the species (highest grade achieved for near 100% of the population) was C18, whereas for "British spruce" (a grade combination of Sitka spruce with typically 10% Norway spruce) is C16. Results also showed that Douglas fir can be graded to higher strength classes with useful yields of grades up to C35.

An important difference to note is that while previous studies showed that machine grading of conifers in both countries is mostly limited by bending modulus of elasticity, in this study the grading of Douglas fir was, for the majority of combinations, limited by the bending strength. The size of knots is key in the bending strength performance, and the forest management could have played an important role in this feature.

The work within WoodProps has helped to boost the interest of the industry in minor species and made possible the first machine grading of Douglas fir in Ireland and the UK by Murray Timber Group in June 2018.

In addition to the material already available, the commercialisation of Douglas fir may favour the planting of the species at a larger scale, contributing to diversification of the forest resource in Ireland and the UK.

As part of the ongoing work, WoodProps is currently investigating the timber quality of larch and Scots pine grown in Ireland, which will guide on the best use of these species coming to harvest age.

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