Artificial weathering effects on glue-bond, varnish stability and surface appearance in thermally modified larch

FP1303: Design Application and Aesthetics of Biobased Building Materials

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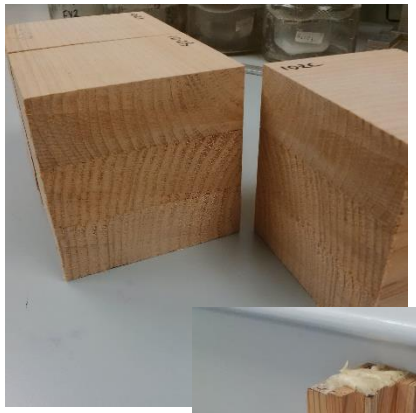
Dr Morwenna Spear

Introduction



- Thermal modification of larch in Wales
- Adding value to fast-grown timber
  - Growth ring width
  - High juvenile wood content
- Joinery market seeks larger cross-section pieces for profile manufacture
- Thermally modify thin (< 30mm) planks
- Laminate to form a square section
- How to test the performance in Use Class 3.1 and 3.2 conditions?

Test development

- Laminates combining different orientations
- Laminates combining juvenile and mature wood
- Laminates combining mild and moderate levels of thermal modification
- Cut down to thin planks (18mm)
- Exposed to EN 927-6 QUV test for paints and coatings, without a mask
- 6 days cycling rainfall and UV
- 1 day of humidity from beneath

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Artificial Weathering Effects on Glue-bond, Varnish Stability and Surface Appearance in Thermally Modified Larch

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INTRODUCTION

A thermal modification process has been developed and trialled in Wales, to add value to locally grown timber. When grown in the UK, larch has a relatively fast growth rate, resulting in wide juvenile wood in the centre of the harvested log and relatively wide growth rings even in the mature wood. The early wood and late wood of this species has a pronounced difference in density, resulting in an uneven surface in planing operations. However, the timber of larch is of good strength, and has many desirable qualities. Thermal modification has been used to alter the machinability of the timber. The thermal modification process developed for this project used a mild or a moderate treatment temperature (Spear et al. 2015) to achieve low-level changes in the material without the extensive modification of hemicelluloses and lignin which are associated with higher temperature thermal modification systems.

There is great interest in lamination of thermally modified larch timber to create thick sections suitable for profiling and window frame manufacture. In this application the bond quality of lamination and the coating or varnish will be exposed to cyclic fluctuations of moisture and the action of UV light. To evaluate the performance of the mild and the moderately treated timber, samples were laminated using a variety of lay-ups with good and bad grain orientation. The aim was to create laminates with best and worst case scenarios for moisture-movement to create strain within the glue bonds and the coatings.

The aim of this section of the project has been to observe the performance of modified larch timber under the action of artificial weathering. This used a cyclic UV and rainfall simulation, alternated with humidity provided from the reverse face. The test has potential for evaluating performance of adhesive bonding in laminated timber under variable moisture conditions.

Spear et al. (2015) Physical properties of UK grown larch subjected to mild and moderate thermal modification processes. In: *Proceedings of the 11th Nordic European Network for Wood Science and Engineering*, Poznan, Poland, pp. 98-104.

MATERIALS AND METHODS

Samples of the thermally modified timber produced at the commercial scale unit at Coed Mon were used in this study. These were prepared for QUV weathering tests using different combinations of coatings and lamination.

Firstly, planed samples were sorted into groups of tangential, half tangential, half radial and radial orientation. Laminates were prepared selecting combinations of these grain alignments, e.g. 4x tangential (shown above), 4x radial, 4x half-tangential with matching angle, radial-tangential-tangential-radial. Within the laminates different combinations of mild and moderate treatment levels were combined, e.g. 4x mild (shown above), mild-moderate alternating. In some cases it was not possible to prepare all combinations of mild and moderate with all grain orientations, due to supply of material and sample size. An expanding polyisocyanate wood adhesive (Gorilla Glue) was used for all laminates.

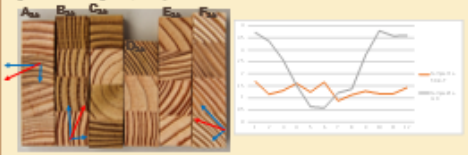
The laminates were approx. 50 mm x 50 mm in cross section after planing. From the laminates

RESULTS

Water swelling tests

Thickness dimensions were recorded at three locations within each segment of the laminate before and after soaking. This allowed values adjacent to the glue bond with the next lamella to be compared with material closer to the centre of the piece. The intention was to observe residual strain resulting from the glue bond on the wood in these interface regions.

The measured values were used to calculate swelling as a percentage of original conditioned dimension and clear differences were seen between sample A (all tangential) and sample B (all radial). In mixed samples, eg. sample C, the radially aligned segments swelled to a lesser degree than the tangential, as expected.



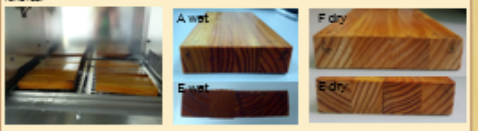
Samples which were soaked showed swelling and distortion relating to the grain orientation. As a result, those with 'balanced' constructions showed minimal distortion, while those with unbalanced construction, e.g. sample C (above) distorted as anticipated, due to differences in swelling between tangential and radial orientations. The swelling in each segment was considered by visualising vector components acting in the tangential and radial orientation. This is shown in the illustration by the blue arrows.

It was therefore expected that these unbalanced sample combinations would exert stress at the interface between lamellae within the laminated samples during weathering.

RESULTS

Weathering tests

The weathering of uncoated larch showed a trend towards a silver colour over the 12 week period. All uncoated samples cupped during the weathering test, regardless of lamination sequence. When coated, the samples retained their original colour beneath the varnish for a longer period. The varnish coated samples showed least degradation of the film when applied to straight grained timber. Samples containing grain deviations or knots induced premature failures.



As expected, differences between samples were seen relating to the lamination construction. These included mild vs moderate treatment level, juvenile wood vs mature wood differences and the tangential vs radial differences. The photograph shows strong swelling in juvenile wood with mild treatment (left hand segment) compared to mature growth ring segments.

Similarly, in sample E, where one segment was tangentially aligned, the swelling was prominent on both the grained and the ungrained surface. After three weathering cycles, delamination was visible at this T-R interface, whereas bonding was intact in the glue lines of the balanced samples.

SUMMARY

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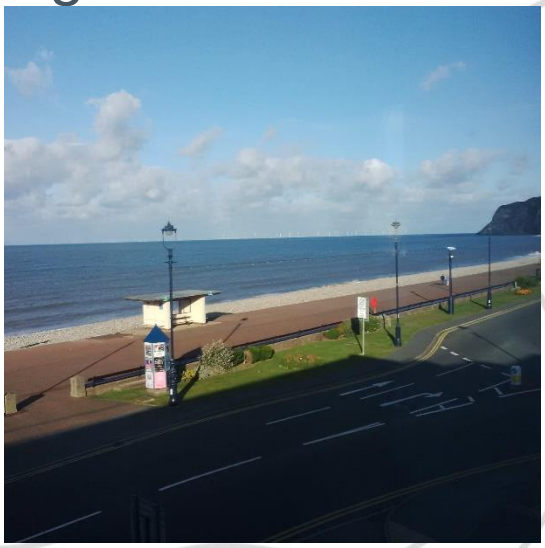

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