UQ Fire Project #2020.15

STRUCTURAL FIRE RESPONSE OF LAMINATED TIMBER WITH INNOVATIVE STITCHED GFRP SYSTEM

Advisory Team
Dr Martyn S. McLaggan (martyn.mclaggan@uq.edu.au) and Dr Cristian Maluk (c.maluk@uq.edu.au)

Keywords
LVL, GFRP, fire performance, structural analysis, Dynamic Mechanical Analysis (DMA)

Background and motivation
This topic will systematically assess and optimise the use of a novel stitched GFRP (Glass Fibre Reinforced Polymer) system in LVL (Laminated Veneer Lumber) to deliver improved structural performance in fire conditions. The failure mechanism of LVL in fire is dictated by the loss of the veneer due to the loss of bonding strength of adhesive resin at elevated temperatures. Loss of veneer results in loss of char layers protecting the inner timber, and expose a fresh timber surface. Therefore loss of veneers significantly increase the rate of loss in available cross sectional area leading to failure of the structural member. Including stitched FRP avoids the falling off of charred timber and thus reduces the rate of cross sectional loss. In addition, FRP fibres also contribute towards load transfer, further increasing the performance of the structural member.
LVL using low grade lumber reinforced with FRP can deliver an efficient material constituting effective material usage. However, the loss of the FRP and veneer layers in the event of the fire inhibit its adoption in practice thus requiring a solution to prevent this from occurring.

Research objectives
This project seeks to illustrate this behaviour on an intermediate-scale under structural and fire loading and to assess the relevant governing parameters.

Methodology
A systematic approach will be followed that allows full analysis of this product on an experimental basis. This will include:

- Identifying the optimal glass fibre loading for improvement in structural performance using a loaded intermediate-scale setup subjected to radiant heat exposure;
- Evaluating the effect of the glass fibres on the thermal decomposition of the timber using a bench-scale flammability calorimeter;
- Assessing the loss of mechanical properties at elevated temperatures using dynamic mechanical analysis (DMA).

Recommended literature
[1] Raftery, G. M. & Harte, A. M. (2011). Lowgrade glued laminated timber reinforced with FRP plate. Composites Part B: Engineering, 42 (4), 724–735.
[2] Martin, Z. A. & Tingley, D. A. (2000). Fire resistance of FRP reinforced glulam beams. WCTE: World Conference on Timber Engineering. July 31-August 3, Whistler Resort, Canada.
[3] Wall, H. Fernando, D. & Maluk, C. (2018). Fire performance of a glulam-FRP composite – proof of concept. WCTE: World Conference on Timber Engineering. August 20-23, Seoul, South Korea.