Abstract

Cross-laminated timber (CLT) is a structural composite, in which layers of crosswise oriented lamellae are glued together, and it is prevalently used for walls and slabs. This composite action is restricted at elevated temperatures because the adhesive and timber deteriorate at a different rate. If the adhesive successfully holds the charred layer, then this char will serve as an "insulating" material. This function makes it possible to design for timber auto-extinction. This is crucial for a successful compartmentation fire strategy, which is critical for tall mass timber buildings. The physical separation between two bonded surfaces is called debonding, which in fire conditions is characterised as delamination and char fall-off. In the current state of the art debonding was found to be influenced by various parameters, starting from manufacturing, timber, and adhesive properties, to the methodology or standards used to test these properties, both in ambient and elevated temperatures.

To study debonding, 30 small scale tests were performed on 3 lamellae CLT blocks, from three different European manufacturers. Two different types of one-component-polyurethane (1-C-PUR), and one melamine-urea formaldehyde (MUF) were used. Samples were simultaneously exposed to a structural load (shear stress of 0.15 and 0.20 MPa) and a thermal load (radiant heat flux of 50kW/m^2). The analysed variables are structural load, bond line temperature at failure, adhesive type, and moisture content.

Four types of failure modes were observed: char fall-off, delamination, local, and mechanical failure. The mean delamination temperatures in the first bond line varied from 78°C (MUF) to 235°C (1-C-PUR). The amount of load placed was only influential for delamination phenomena, where samples experienced delamination at the higher load. Moisture movement was noticed to be an influential factor, but its impact could not be quantified.

The method developed in this work is suitable to observe delamination, there are however some limitations to this approach. To address the issue of char-fall off, the changes in geometry are required (lamellae number and thickness). The high percentage of the local failure at the top of the front lamella also indicated the need for further refinement. The method used in this study can successfully address some of the issues, but more research is needed so that the designer can "*hold the line, hold the bond line!*".