ABSTRACT

The global movement to reduce the carbon footprint in the construction industry has refueled interests in sustainable construction materials. Engineered wood products like Cross Laminated Timber (CLT) have facilitated this transition owing to numerous advantages compared to steel or concrete. CLT like other timber products degrades and combusts under fire, losing structural capacity in the process. This study aims to numerically evaluate the structural fire performance of CLT walls according to EN 1995-1-2 under different fire curves and perform a parametric study to investigate the optimal CLT buildup for best performance in fire.

A one-dimensional transient heat transfer model was employed to predict the temperature distribution in-depth of a CLT cross-section while accounting for temperature dependent thermal properties modeled according to the advanced method outlined in Annex B of EN 1995-1-2. A decoupled structural model accounting for the reduction in strength and stiffness based on the thermomechanical properties outlined in Annex B of EN 1995-1-2 is used to predict the crushing and buckling load capacity of the CLT. The reduced cross-section method (RCSM) and recoverability of strength during cooling was also incorporated.

The intensity and duration of a fire influenced the extent of loss in capacity and further strength reduction was observed during the cooling phase. The RCSM overpredicted the crushing capacity in all cases while conservative results were obtained for buckling when the effective char depth penetrates the second and third plies for 3-ply, and 5 and 7-ply CLTs, respectively. Changes in end restraints or wall height mainly affected ambient capacity with minimal effect on fire performance. CLTs with thicker longitudinal plies have been found to outperform other ply arrangements. Under a short fire, 3-ply CLTs with thicker longitudinal plies outperformed other CLTs. Under more severe fires, 7-ply CLTs with thicker longitudinal plies were better performing.