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NOVEL TESTING FOR STIFFNESS REDUCTIONS OF CROSSLAMINATED TIMBER AT ELEVATED TEMPERATURE

A novel dynamic testing method has been used to study changes in flexural elastic modulus of Cross-Laminated Timber (CLT) with elevated temperature. The elastic modulus is an important parameter for estimation of the structural response of CLT structures to fire and, using this dynamic method, it can be measured with a small, unobtrusive sensor.

A sectional analysis model was developed to estimate the reduction in stiffness of CLT beams in bending at elevated temperatures, and experiments were conducted using modal analysis in an attempt to validate the predictions made. The model comprised two parts: a two-dimensional heat transfer model that estimates the temperature profile within the CLT elements, and a stiffness reduction model which is based on the decrease in the elastic modulus of CLT at elevated temperatures along with a sectional analysis. T

he model was validated by conducting experiments on four different CLT beams of dimensions 3 x 0.1 x 0.3 m. The beams were heated from ambient conditions within a specialised heating chamber capable of maintaining a gas temperature of 140 °C. Thermocouples were used to record the thermal gradients within the beam with time, and to compare these values against those predicted by the model. The reduction in dynamic flexural stiffness was measured periodically by exciting the beam and recording the response of an attached high-temperature accelerometer.

It was found that the thermal properties suggested in Eurocode 5 resulted in reasonable estimates of the temperature profiles recorded during the tests. Results also showed that most used modulus reduction models over-predicted the measured reduction of dynamic elastic modulus at elevated temperatures. The results suggest that the reduction of modulus of elasticity in timber is not only a complex function of temperature, but is also influenced by other parameters dependent on temperature such as moisture transport, cracking, and creep.