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Effect of Realistic Boundary Conditions on the Behaviour of Cross-Laminated Timber Elements Subjected to Simulated Blast Loads

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Summary:

Cross-laminated timber (CLT) is an emerging engineered wood product in North America. Past research effort to establish the behaviour of CLT under extreme loading conditions has focussed CLT slabs with idealized simply-supported boundary conditions. Connections between the wall and the floor systems above and below are critical to fully describing the overall behaviour of CLT structures when subjected to blast loads. The current study investigates the effects of “realistic” boundary conditions on the behaviour of cross-laminated timber walls when subjected to simulated out-of-plane blast loads. The methodology followed in the current research consists of experimental and analytical components. The experimental component was conducted in the Blast Research Laboratory at the University of Ottawa, where shock waves were applied to the specimens. Configurations with seismic detailing were considered, in order to evaluate whether existing structures that have adequate capacities to resist high seismic loads would also be capable of resisting a blast load with reasonable damage. In addition, typical connections used in construction to resist gravity and lateral loads, as well as connections designed specifically to resist a given blast load were investigated. The results indicate that the detailing of the connections appears to significantly affect the behaviour of the CLT slab. Typical detailing for platform construction where long screws connect the floor slab to the wall in end grain performed poorly and experienced brittle failure through splitting in the perpendicular to grain direction in the CLT. Bearing type connections generally behaved well and yielding in the fasteners and/or angles brackets meant that a significant portion of the energy was dissipated there reducing the energy imparted on the CLT slab significantly. Hence less displacement and thereby damage was observed in the slab. The study also concluded that using simplified tools such as single-degree-of-freedom (SDOF) models together with current available material models for CLT is not sufficient to adequately describe the behaviour and estimate the damage. More testing and development of models with higher fidelity are required in order to develop robust tools for the design of CLT element subjected to blast loading.

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