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DUCTILITY BASED FORCE REDUCTION FACTORS FOR SYMMETRICAL CROSS-LAMINATED TIMBER STRUCTURES

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ABSTRACT

Ductility Based Force Reduction Factors for Symmetrical Cross-Laminated Timber Structures

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Summary:

Cross-laminated timber (CLT) as a structural system has not been fully introduced in European or North American building codes. One of the most important issues for designers of CLT structures in earthquake prone regions when equivalent static design procedure is used, are the values for the force modification factors (R-factors) for this structural system. Consequently, the objective of this study was to derive suitable ductility-based force modification factors (Rd-factors) for seismic design of CLT buildings for the National Building Code of Canada (NBCC). For that purpose, the six-storey NEESWood Capstone wood-frame building was redesigned as a CLT structure and was used as a reference symmetrical structure for the analyses. The same floor plan was used to develop models for ten and fifteen storey buildings. Non-linear analytical models of the buildings designed with different Rd-factors were developed using the SAPWood computer program. CLT walls were modelled using the output from mechanics models developed in Matlab that were verified against CLT wall tests conducted at FPInnovations. Two design methodologies for determining the CLT wall design resistance (to include and exclude the influence of the hold-downs), were used. To study the effects of fastener behaviour on the R-factors, three different fasteners (16d nails, 4x70mm and 5x90mm screws) used to connect the CLT walls, were used in the analyses. Each of the 3-D building models was subjected to a series of 22 bi-axial input earthquake motions suggested in the FEMA P-695 procedure. Based on the results, the fragility curves were developed for the analysed buildings. Results showed that an Rd-factor of 2.0 is appropriate conservative estimate for the symmetrical CLT buildings studied, for the chosen level of seismic performance.

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