Kinematic Behaviour of Cross Laminated Timber (CLT) Shearwalls with Openings

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Summary:

An integrated experimental and numerical research program investigating the elastic and inelastic performance as well as the kinematic behaviour of shearwalls with openings is presented in this study. The influence of the geometrical dimensions of the wall configurations and the mechanical properties and configurations of hold-downs on both elastic and inelastic behaviours including the possible kinematic modes of the shearwalls are investigated. The research also proposes the concept of equivalent-frame-model applicable for shearwalls where openings are cut-out from CLT panels. Are also presented, five racking tests performed on full scale CLT walls in order to validate the numerical models as well as the equivalent frame model. From review of the available literature emerges that for CLT shearwalls with openings, studies are not at the same level of abundance in research compared to walls without openings, due to the simple reason that SSW is generally a widespread technique. Thus, the kinematic behaviour and the coupling effect are inexistent and presented here. The investigations of the wall's behaviour in the elastic and inelastic ranges demonstrate the important effect of the lintel and wall segment slenderness as well as the hold-down stiffness effect on the mechanical behaviour and the global kinematic behaviour as well. It is found that the kinematic modes can change when the walls are stressed beyond their elasticity limit. The failure mode and the global ductility are highly dependent on the hold-down configurations particularly for walls with door openings. The degree of coupling decrease with increased hold-down stiffness and the wall segment width. With regards to the equivalent frame model, a reasonable fit is found between the proposed EFM and a detailed 2D area element model when the global elastic stiffness and tensile load in the hold-down were compared. The model is successfully validated through five full-scale tests on CLT shearwalls with door or window opening as well as two published studies on walls with door openings. The EFM is capable of predicting the behaviour in the wall with reasonable accuracy, especially for walls whose behaviour was dominated by the hold-down behaviour.

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