Numerical modelling of light-frame timber walls with focus on out-of-plane deformations and elastic-plastic fastener force distribution

L. Kuai†*, S. Ormarsson† and J. Vessby‡

†Building technology, Linnaeus University, le.kuai@lnu.se, sigurdur.ormarsson@lnu.se
‡Building technology, Karlstad University, johan.vessby@kau.se

Light-frame timber walls in volume modules act typically as shear walls to resist lateral wind loads. The load bearing structures of these type of walls consist of numerous slender timber elements (studs, rails, noggin pieces, door and window sills and different types of fibre- or plasterboards) that are connected together by a huge number of mechanical nail, staples or screw joints. The challenge is to model the different types of mechanical connections both properly and efficiently. The work presented here is a further development of the wall models presented in [1] and [2], where it is now focused on both elastic and plastic behaviours of the mechanical connections between the timber frame and the plasterboards. Since the plasterboards sit on the inside of the timber frame, the walls function as an unsymmetrical structure when they are loaded in an in-plane shear action.

To keep the size of the model as small as possible the FE-model is made of simple structural elements, i.e. straight beam elements for studs, rails and mechanical fasteners and planar shell elements for the plasterboards. To show better how the different elements are assembled and connected together Figure 1*(b)* shows the different structural elements used and symbols for spring connections of a typical timber frame wall.

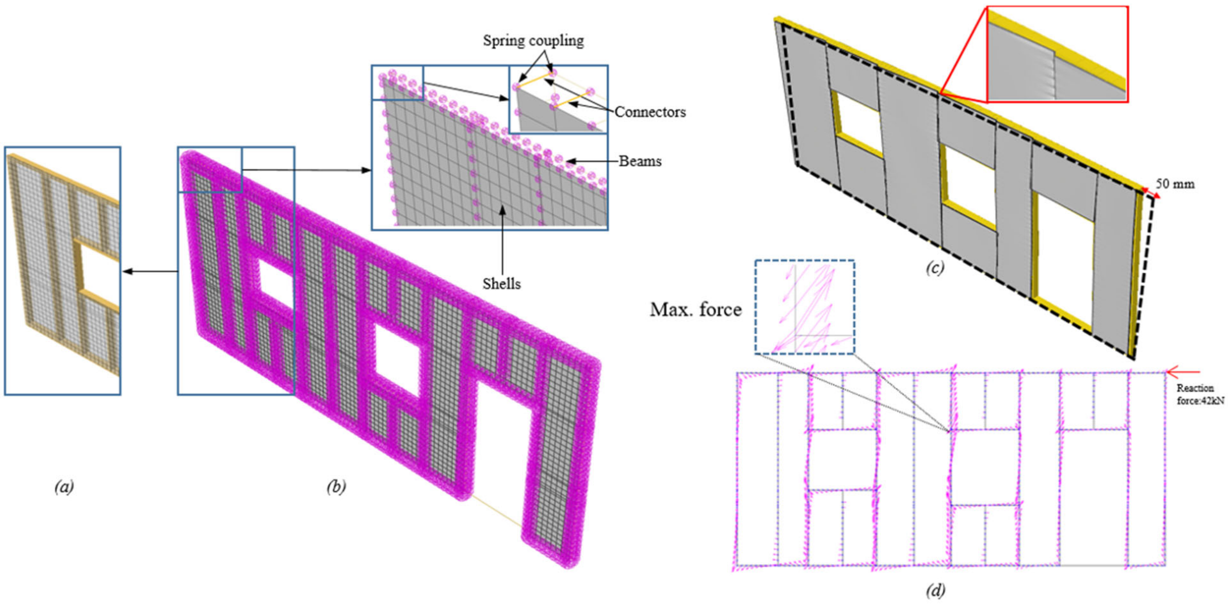

Figure1: Model illustration of a light-frame timber wall, *(a)* a 3D-view of a part of the wall, *(b)* element mesh and symbols used for spring coupling between the elements, *(c)* out-of-plane deformation and close-up on a slippage deformation between two plasterboards, *(d)* elastic fastener force distribution in the wall.

To illustrate the timber frame structure Figure 1*(a)* shows a 3D-view of a part of the wall element. Figure 1*(c)* shows clear out-of-plane bending of the wall element because of the eccentric force action in the element and a visible slippage deformation between two of the sheathing boards. Figure 1*(d)* shows the elastic fastener force distribution in the timber wall exposed to in-plane shear loading. The largest fastener forces seems to occur close to the corners of the largest plasterboards or close to window corners. These forces can be directly implemented in the design equations used for the individual shear connections. Based on reasonable input data the simulation model gives valuable information regarding both the global structural behaviour of the timber wall and the fastener forces acting in all mechanical connections. To facilitate the creation and assembly of all the timber components the model needs to be fully parameterized to increase its flexibility to analyse different types of timber walls.

References

[1] Kormendy, I., and Muwaili, M., (2018). "*Timber Shear Wall Analysis - Parameterized Finite Element Modelling*", Master Thesis, Linnaeus University, Department of Building Technology, Växjö, Sweden.
[2] Ormarsson, S., and Johansson, M., (2018). "Finite element simulation of global structural behaviour of multifamily timber buildings using prefabricated volume modules." In *WCTE 2018 World Conference on Timber Engineering*. August 20-23, Seoul, Rep. of Korea.

ISBN: 978-91-88898-64-7