Numerical and experimental study on light-frame test-modules for modular-based timber structures

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Today Sweden has a significant housing shortage. The authority "National Board of Housing" has stated that 700,000 flats need to be built by 2025. Building with prefabricated light-frame volume modules is an existing and innovative construction method for low and mid-rise timber buildings. Compared to traditionally site-built constructions this method is very advantageous due to its high prefabrication level and the fast on-site assembly of the modules. The volume modules are also manufactured in a well-controlled factory climate, where the wood material can retain its good quality. This work presents results from two ongoing research projects concerning numerical and experimental study of modular-based timber buildings. The final aim of this work is to develop an efficient three dimensional finite-element model to analyse both the global and detailed structural behaviour of these types of buildings.

To study the overall shear stiffness of the volume modules, eight different test-modules are to be tested. The main focus is to study (and optimise) the global shear stiffness of the test-modules. In addition, the shear stiffness of the mechanical (or friction based) connections between the modules will be tested. Regarding structural safety, connection design is an important task that needs to be numerically studied and experimentally verified. The test results will be used to calibrate the numerical model, see [1]. Figure 1 shows some results from the experimental study and the simulation.

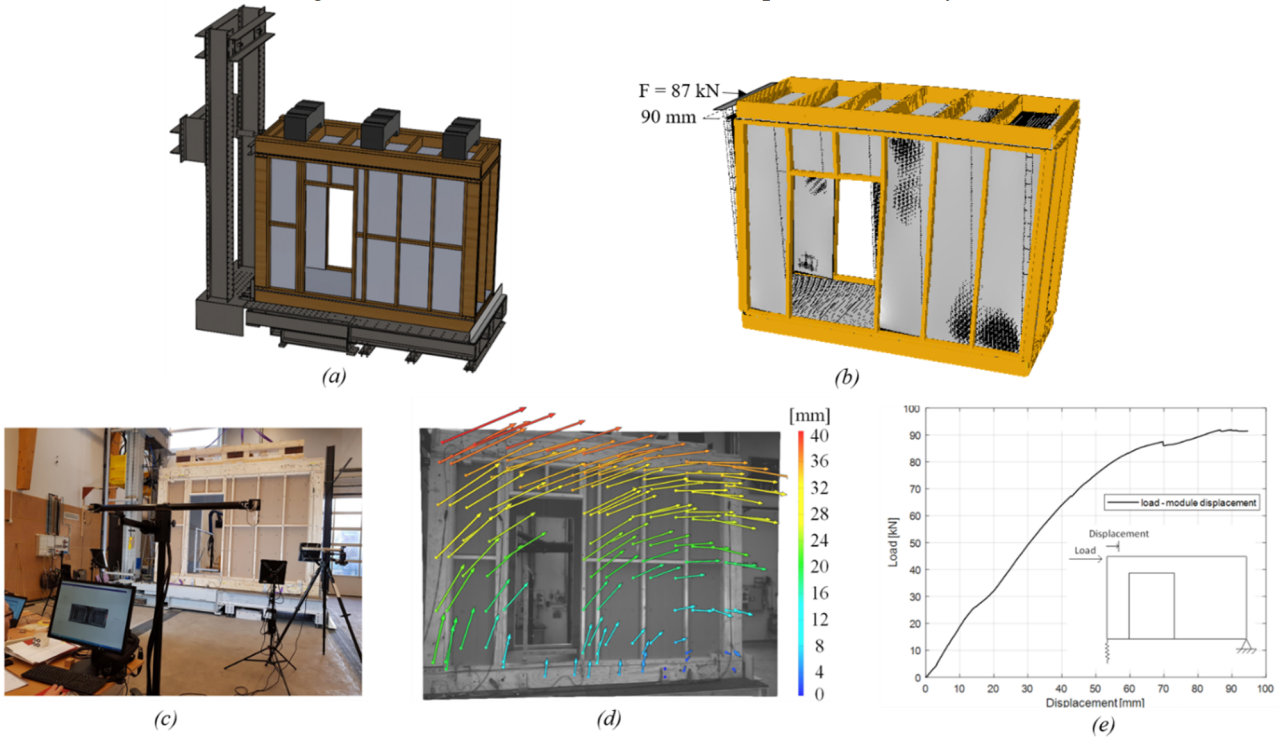

Figure1: Experimental and simulation results, *(a)* 3D drawing of the experimental facility used, *(b)* simulated deformations of the test-module studied, *(c)* the test setup with the DIC system and the potentiometers, *(d)* the displacement vectors from the DIC system, *(e)* the global load-displacement curve for the test-volume.

The experimental result for the first module showed the module to be both stiffer and stronger than expected. The mechanical connections worked very well and the global load-displacement curve in Figure 1*(e)* shows linear variation up to a high load level. The different test results were used to validate the simulated deformations of the test-module shown in Figure 1*(b)*. The experimentally-based stiffness values found for the mechanical connections shows clearly the importance of the different connection stiffness on the global module behaviour.

References

[1] 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.

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