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"FEM strategies for numerical modeling of DendroLight cellular wood material core"

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I. INTRODUCTION

DendroLight is a novel wood material primarily used as core material for furniture industry. The manufacturing of this material was started at the year 2010 in Ventspils. It is made from profiled/perforate wood boards stacked in perpendicular layers and then sliced once more in plates perpendicularly to the board's layers. The main advantage of such a solution is significant reduction of structural weight (up to 40 %) comparing to conventional timber. Material properties are not fully assessed jet, however first experimental test runs demonstrate that it has sufficient stiffness for the use as core material in wood sandwich panels in load bearing structures like walls and floors[1]. For further development of load bearing structures with DendroLight core, reliable design methodology is needed, able to assess detailed geometry component (like profiled board web thickness) influence over the stiffness for large scale structure.

In current research several numerical modeling techniques have been compared including numerical models from shell and solid elements in ANSYS and ABAQUS software. The aim is to elaborate an accurate numerical model for prediction of DendroLight structure mechanical behavior. Precision of numerical model is estimated comparing displacements of experimentally tested small scale specimens in compression and bending with mechanical responses of numerical model.

II. NUMERICAL MODELING

In general, cellular wood structure created in sequence of real production process, starting with profiled board modelling, forming layers and cutting blocks into DendroLight® layers (Figure 1). Boundary and loading conditions have been set according to experimental test set up. Wood mechanical properties are taken according Wood Handbook [2] for pine and spruce species. Corresponding isotropic mechanical properties have been assigned also to High Density Fiberboard (HDF) skins for bending specimens. Structural loads were assigned to sets of nodes with jointed deflections along vertical direction. Only linear analysis has been conducted to reduce calculation effort.

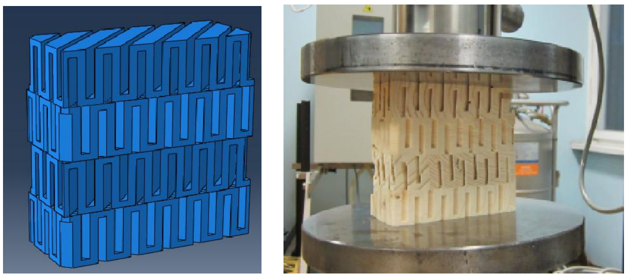

Fig. 1. Numerical model of compression specimen and equivalent experimental test (on the right)

III. EXPERIMENTAL INVESTIGATION

Specimens have been tested in compression and bending on ZWICK Z100 testing equipment (Figure 2). All specimens for bending set-up have 4 mm thick HDF skins. Mechanical properties of DendroLight® largely depend on wood cell direction; therefore specimens with different orientations have been evaluated. Compression specimens have dimensions of 100x100x40 mm and bending specimens 300x50 mm with 30 and 60 mm thickness.

IV. RESULTS AND DISCUSSION

Load displacement curves from experimental tests and numerically acquired displacements are plotted in Figure 2 for compression specimen with transverse DendroLight orientation.

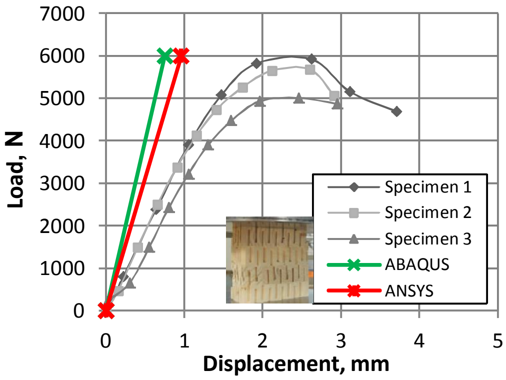

Fig. 2. Experimentally obtained displacement values compared with numerical results for compression specimens

Experimental results have clear elastic mechanical behaviour region until 80 % of critical load. In this range numerical models shows sufficient accuracy predicting mechanical behaviour of structure under loading conditions. Usually scatter between experimental and numerical results are in 20 % bounds. Largest scatter may occur for specimens with transversial DendroLight orientation (Fig.2) – up to 40 %. It might be caused by weaker wood mechanical properties in radial direction or inappropriate bounding in numerical model. Overall stiffness of numerical models is higher than experimental. Model made from shell elements in ANSYS has shorter calculation times than model from solid elements in ABAQUS.

Further investigation is required to improve numerical model`s accuracy.

V. REFERENCES

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