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MODELLING OF CROSS-LAMINATED SOLID WOOD PANELS

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ABSTRACT

The objective of this study was to develop a finite element model of the hygromechanical warping of three-layered cross-laminated solid wood panels. The middle layer is glued with a rotation of 90° relative to the outer layers. Observations in full scale buildings, where panel warping is found to develop as a troublesome result of different climates at the two panel faces, were transferred to the laboratory scale: the moisture distribution and the deflection of 300×300 mm^2 sized panels subjected to a climate gradient were measured. The test results were used to validate the present moisture and deformation simulation models. The modelling of the moisture movement was based on Fick's second law of diffusion (see, e.g., [1]). Considering a faster diffusion at higher wood moisture contents, the coefficient of diffusion of the wood was formulated as moisture dependent. The diffusion hindering effect of the adhesive bond lines is significant and was taken into account by a reduction of the diffusion coefficient of the 0.1 mm thick layers that represented the adhesive. In the mechanical part of the problem the total strain rate was assumed to be the sum of elastic strain rate $\dot{\varepsilon}_{el}$, moisture induced swelling $\dot{\varepsilon}_{\omega}$ and mechano-sorptive strain rate $\dot{\varepsilon}_{\omega\sigma}$:

$$\dot{\varepsilon} = \dot{\varepsilon}_{el} + \dot{\varepsilon}_{\omega} + \dot{\varepsilon}_{\omega\sigma} \; . \tag{1}$$

This model was applied to and validated for moisture induced distortions of sawn timber in [2]. Equations that defines the moisture dependency of the material parameters allowed for adjustment of the wood behaviour to the actual moisture state in each time step. The orientation and location of the cylindrical coordinate systems of the lamellas in each wood panel layer were referred to the orthotropic material directions of wood. The influence of the material parameters such as Young's modulus, coefficients of hygroexpansion or coefficient of diffusion was investigated in a sensitivity analysis. Furthermore, annual growth ring orientation and geometry data such as layer thickness were studied with respect to the influence on the magnitude of hygroscopic warp. The good agreement between the experimental and numerical data suggests that the model reflects the behaviour of cross-laminated solid wood panels very well. The present moisture and deformation models can be succesfully used in further investigations of the performance of wood panels.

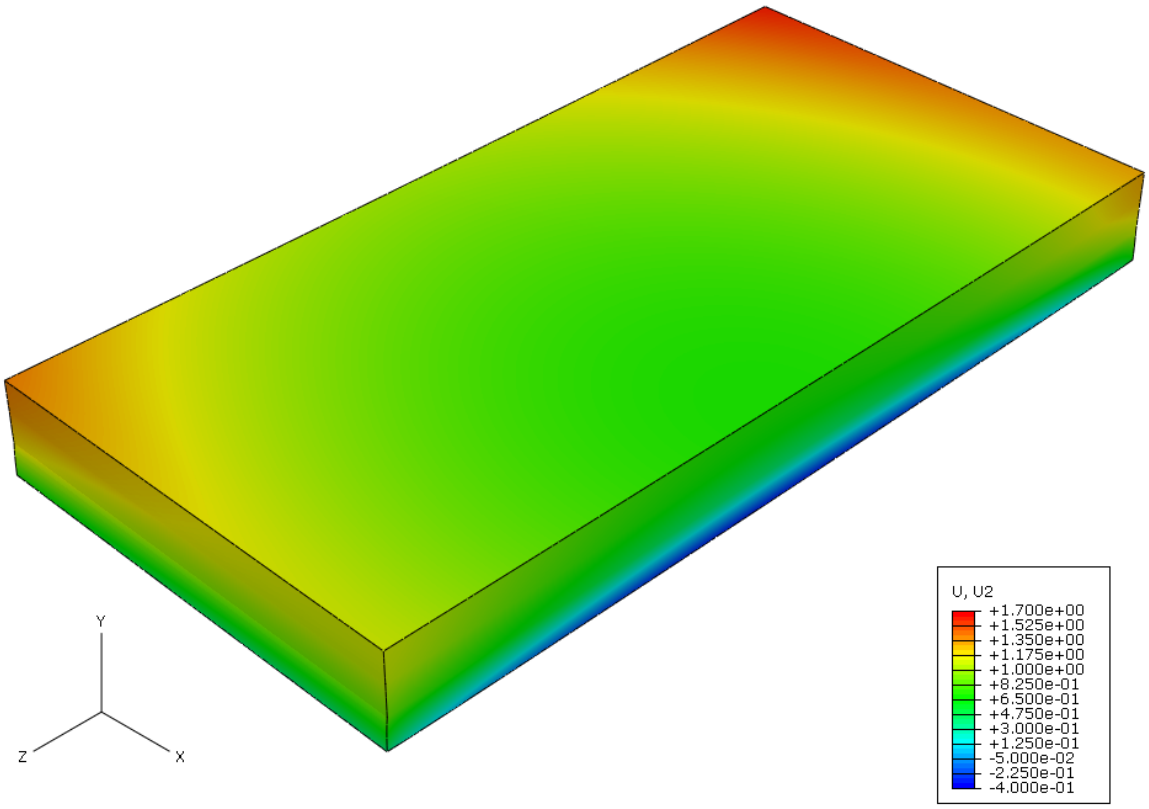

Figure 1: Typical finite element modelling prediction of warping displacement u_y (mm) due to a climate gradient. Only one half of the panel is diplayed.

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REFERENCES

[1] J. F. Siau. *Wood: Influence of moisture on physical properties*. Departement of Wood Science and Forest Products, Virginia Polytechnic Institute and State University, Blacksburg, USA, 1995.

[2] S. Ormarsson. *Numerical analysis of moisture-related distortions in sawn timber*. PhD thesis, Chalmers University of Technology, Göteborg, Sweden, 1999.