FEM modelling of wood cell deformation under dynamic loads

S. Fortino*† and P. Hradil†

*† VTT Technical Research Centre of Finland, P.O. Box 1000 FI-02044 VTT Finland
E-mail: stefania.fortino@vtt.fi - Web page: http://www.vtt.fi

† VTT Technical Research Centre of Finland, P.O. Box 1000 FI-02044 VTT Finland
E-mail : petr.hradil@vtt.fi - Web page: http://www.vtt.fi

ABSTRACT

Dynamic compressive and shear loads applied to wet woodchips at high values of speed and temperature during thermo-mechanical pulping are aimed at separating wood fibres from the raw material to increase both the flexibility and the bonding ability of the fibres [1,2]. However, further research is needed to deeply understand the complex mechanisms at the origin of wood cell disintegration.

Recent studies have pointed out the importance of both experimental and computational research at the microscale of wood to define the properties of this hygroscopic and highly anisotropic material as well as to understand the complex phenomena occurring in wood cells under different processes and environments [3,4]. A Swedish research presented in [1] has provided interesting experimental results in regards to wet wood cell deformation and measurements of the work done under different low speed loads (see references in [2]). A finite element model was also introduced to simulate the deformation of cells in [2].

The present study proposes a flexible FEM tool for Abaqus code based on the data presented in [2]. It uses an automated script for parametric model generation combined with a Vmat user subroutine [5]. The model is able to analyse the influence of different geometrical parameters on the cell wall opening and the effect of contacts among cell walls during loading. Compared to previous FEM models, the influence of the plastic behaviour of wood cells under compression [6] is also investigated. The numerical method provides results in terms of load-displacement curves with the aim to obtain important suggestions for the energy saving during thermo-mechanical pulping processes.

REFERENCES

[1] De Magistris F., Salmén L., “Deformation of wet wood under combined shear and compression”. *Wood Sci Technol* **39**, 460-471 (2005).

[2] De Magistris F., Salmén L., “Finite Element modelling of wood cell deformation transverse to the fibre axis”. *Nordic Pulp and Paper Research Journal*, **23** (2), 240-246 (2008).

[3] Hofstetter K., Gamstedt, E., “Hierarchical Modelling of Microstructural Effects on Mechanical Properties of Wood. A Review”. *Holzforschung* **63**, 130-138 (2009).

[4] Qing H., Mishnaevsky Jr. L., “3D multiscale micromechanical model of wood: From annual rings to microfibrils”. *International Journal of Solids and Structures* **47**, 1253-1267 (2010).

[5] Abaqus User’s Manual, Version 6.11-1. 2011, Dassault Systèmes.

[6] Nairn J. A., “Numerical simulations of transverse compression and densification in wood”. *Wood and Fiber Science* **38**(4): 576 – 591 (2006).