Computed tomography-based modelling of moisture transport and hygro-mechanical behaviour of sawn timber during kiln drying

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Mathematical models play an important role in understanding the moisture transport and the hygro-mechanical behaviour of sawn timber during kiln (i.e. air-circulation) drying and the development of new drying schedules used in sawmills. The industrial X-ray computed tomography (CT) scanners available at sawmills can provide data on the internal density distribution of sawn timber from which geometry, moisture content, pith location, annual ring pattern, knots, and defects can be determined using image processing algorithms [1,2]. These data can be used to build mathematical models, experimentally validate such models, and optimise drying schedules.

The aim of the current study is to investigate which modelling parameters, such as dry density, initial moisture content, and heartwood to sapwood ratio, have a significant influence on the stress development of sawn timber during kiln drying. To perform this study a validated CT-based three-dimensional finite element model is used. The numerical model consists of two individual models that are solved in sequence: a moisture transport model based on a single-Fickian approach and a hygro-mechanical model that can describe the wood's elastic, hygro-expansion, creep and mechano-sorptive behaviour [3]. The geometric features of the sawn timber, including the fibre orientation around knots, will be constructed based on a recently developed image processing algorithm used to analyse CT data [1]. The moisture content and displacement data needed to perform the validation of the numerical model were obtained with the image processing algorithm developed by Hansson et al. [2].

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