



HAL
open science

One-dimension visco-elastic modelling of wood in the process of formation to clarify the Hygrothermal Recovery behavior of tension wood

Marie Capron, Sandrine Bardet, K. C. Sujan, M. Matsuo, H. Yamamoto

► To cite this version:

Marie Capron, Sandrine Bardet, K. C. Sujan, M. Matsuo, H. Yamamoto. One-dimension visco-elastic modelling of wood in the process of formation to clarify the Hygrothermal Recovery behavior of tension wood. *CompWood 2017*, Jun 2017, Vienne, Austria. pp.50. hal-01553677

HAL Id: hal-01553677

<https://hal.science/hal-01553677>

Submitted on 6 Jul 2017

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

One-dimension visco-elastic modelling of wood in the process of formation to clarify the Hygrothermal Recovery behavior of tension wood

M. Capron^{†**}, S. Bardet², K.C. Sujan^{†*}, M. Matsuo[†] and H. Yamamoto[†]

[†]Graduate School of Bio-agricultural Sciences, Nagoya University, marie.capron@esrf.fr

²Laboratoire de Mécanique et de Génie Civil (LMGC), Université Montpellier, sandrine.bardet@umontpellier.fr

[‡]ESRF – The European Synchrotron

[‡]Institute of Wood Technology, Akita Prefectural University, Graduate School of Bioresource Sciences

Wood production on stem by deposit of concentric layers on its periphery are going along with the setting up of growth stress. Growth stress has two origins: (1) loading due to weight of the structure is applied progressively when the tree is growing; (2) cell maturation, which happened at the end of the deposit of a new layer, causes an expansion, called maturation deformation, which can't happen freely due to the previous layer and lead to the creation of initial growth stress [1]. The growth stress can be released during cutting and also during hygrothermal treatment (HT), it can be called Hygrothermal Recovery (HTR) [2]. In this work, an one-dimension rheological modelling of wood in the process of formation is proposed to clarify the HTR behavior of Tension Wood (TW). This study focuses on the longitudinal dimensional changes. The rheological analogy is made of a series of four elements (Fig. 1): an elastic element represented by a spring of compliance S_0 which is equal to that of mature wood; a deformation mechanism, α , representing the expansion tendency during maturation; and two visco-elastic elements represented by a spring of compliance S_1 and S_2 in parallel with a dashpot also called Kelvin-Voigt model.

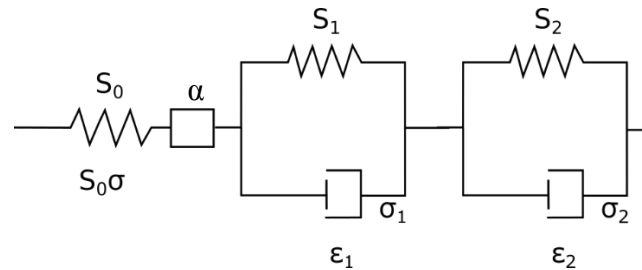


Figure 1: Rheological analogy representing the modelling using of 2 Kelvin-Voigt with α the maturation strain, S_0 the elastic or mature compliance and S_1 and S_2 the delayed compliance.

In order to find a coherent modelling parameters, a fitting with experimental data has been done using different samples from three species konara oak (*Quercus serrata* Murray), urihada maple trees (*Acer rufinerve* Siebold et Zucc.) [3] and keyaki (*Zelkova serrata* Makino). The modelling is able to fit the different parts of HTR for TW (Fig. 2).

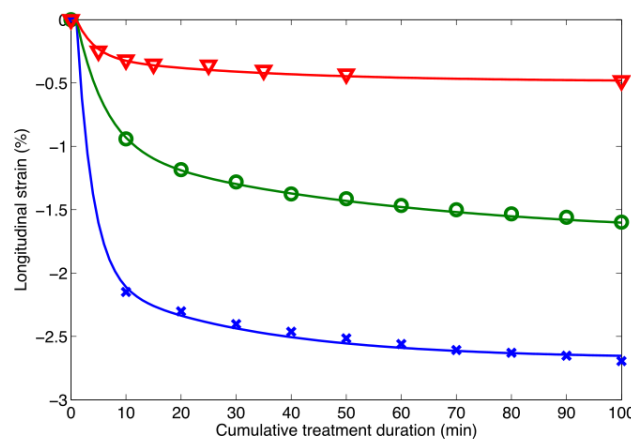


Figure 2: Longitudinal strain change as a function of cumulative treatment duration experimental data for *Urihada maple* (o), *Konara oak* (x) and *Keyaki* (v) (TW) and their modelling using two visco-elastic elements (-).

References

- [1] R.R. Archer: Growth Stresses and Strains in Trees. Springer Series in Wood Science – Hardcover, 1986.
- [2] H. Kubler: Growth stresses in trees and related wood properties. *Forest Products Abstracts*, 10 (1987), 61-119.
- [3] K.C. Sujan, H. Yamamoto, M. Matsuo, M. Yoshida, K. Naito, T. Shirai: Continuum contraction of tension wood fiber induced by repetitive hygrothermal treatment. *Wood Science and Technology*, 49 (2015), 1157-1169.