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Modeling hygrothermal recovery of wood in relation with locked-in strains during tree life

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Where do locked-in strains come from ?

1. Cell maturation process



- last step of the genesis of a wood cell
- increase of rigidity
- tendancy to shrink along the fibre and expand transversally
- deformations are prevented by previously formed

How to release locked-in strains?

1. Elastic part = short-term viscous strains





layers > longitudinal tension and tangential compression **2.** Loading history during tree life

• formation of layers : redistribution of tangential stresses

- successive disposition of concentric layers
- growth stress depends on radial position

 $^{\downarrow} \rightarrow$ inversion of stress (T: compression near the bark, Recent wood tension near the pith) Old wood

> pre-stress level of the wood in the tree depends on the direction and the age of wood







HTR in T and R direction in the literature :

| Reference | Duration (min) | T °C | Species |
|--------------------------|-------------------|------|--|
| Koehler, 1933 | 1440 | 89 | Pine, birch, oak |
| Mac Lean, 1952 | 30-45 | 99 | Maple, beech, poplar, oak, hickory, douglas, fir, spruce, |
| Kubler, 1959 | 150 | 95 | Beech |
| Grzeczynsky, 1962 | 60 | 100 | Beech |
| Yokota and Tarkow, 1962 | 180 | 80 | Sitka spruce |
| Sasaki and Okuyama, 1983 | 60 | 100 | Sugi |
| Gril et al., 1983 | 60 | 90 | Jujube tree |

Radial HTR against tangential HTR from literature

Radial and tangential HTR conditions from literature

Experimental study

 $\rightarrow \leftarrow$



- → reversible deformation
- - \rightarrow viscoelastic recovery of growth stains generated after maturation





Experimental device for HTR