Wood dimensional changes as consequence of its hygroscopic behavior

João Costa, Jorge Branco, Aires Camões & Ana Coelho

Workshop

Hierarchical structure and mechanical characterization of wood

University of Minho
Department of Civil Engineering

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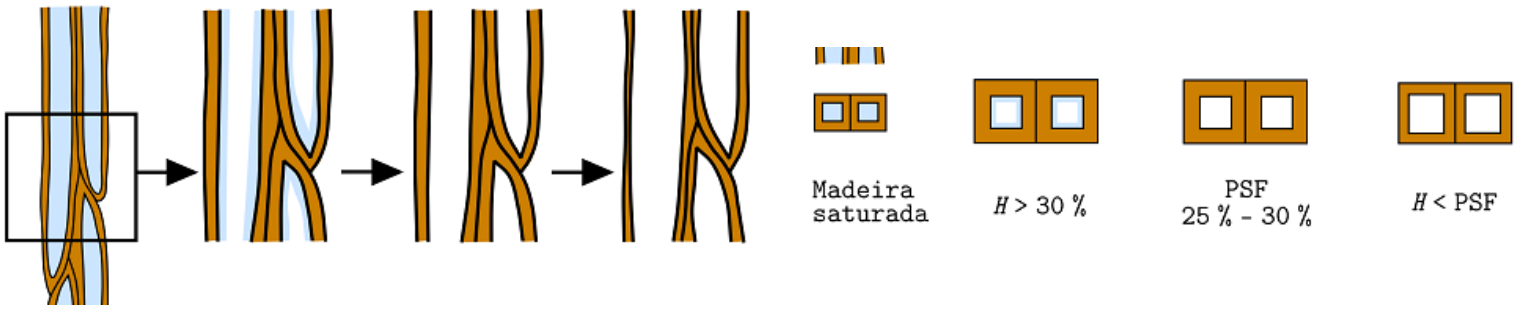
Motivation (I)

Wood is hygroscopic - modifications of the relative humidity and temperature of the surrounding air causes variation of the moisture content (MC):

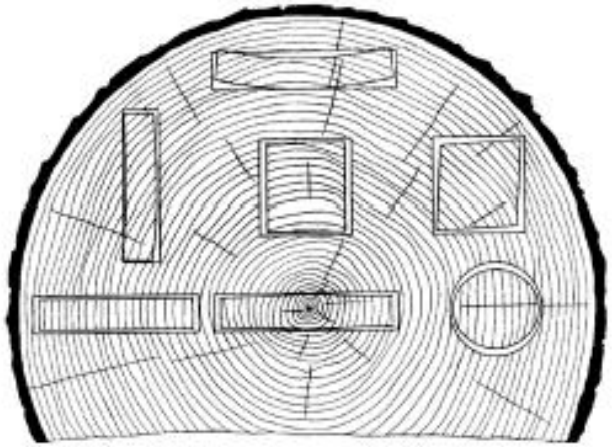
✓ Above fiber saturation point (MCfs) wood is dimensionally stable

✓ Below, wood changes dimensions as it gains moisture (swells) or loses moisture (shrinks)



Motivation (II)

Wood is anisotropic - shrinks (or swells) most in the direction of the annual growth rings (tangentially), about half as much across the rings (radial), and only slightly along the grain (longitudinal)



This moisture relationship has an important influence on wood properties and performance

Objectives

- ✓ **Measure wood equilibrium moisture content of three coniferous wood species: Maritime pine (*Pinus pinaster*), Scots pine (*Pinus sylvestris*) and Spruce (*Picea abies*), trough two distinct methods: with a thermo hygrograph and using the oven dry method**

- ✓ **Evaluate the dimensional stability of the three woods under study**

Experimental work – Specimens and procedure

Specimens: 60 Spruce + 80 Maritime pine + 80 Scots pine

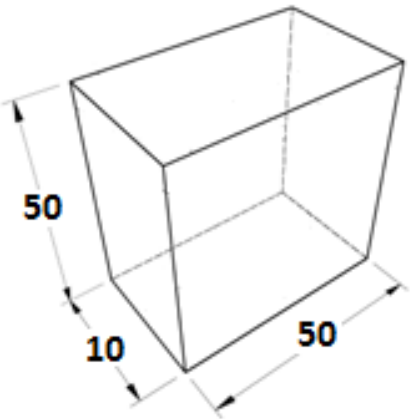
1) Each group of specimens was divided into two subgroups, being the specimens of one subgroup saturated and the ones of the second, dried

2) Then, the specimens of each subgroup were all placed in a climatic chamber with the references conditions of RH = 60% and T=20ºC.

MC of the specimens changed until achieving the hygroscopic equilibrium with the environment

Experimental work – Procedure and setup

By measuring their dimensions it was possible to quantify the dimensional variation suffered during this process



(mm)

ISO 3120:1975

Precision of 0,001mm

Experimental work – Procedure and methods

In each measurement, the moisture content of the wood specimens was measured trough two methods:

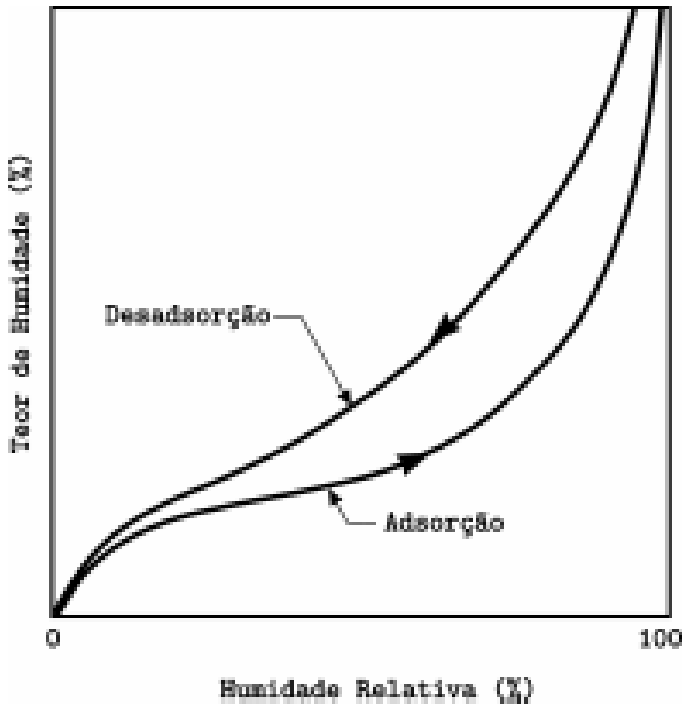
1. **using the oven dry method (EN 13183-1)**
2. **with a thermo hygrograph (EN 13183-2)**

Experimental work - Results

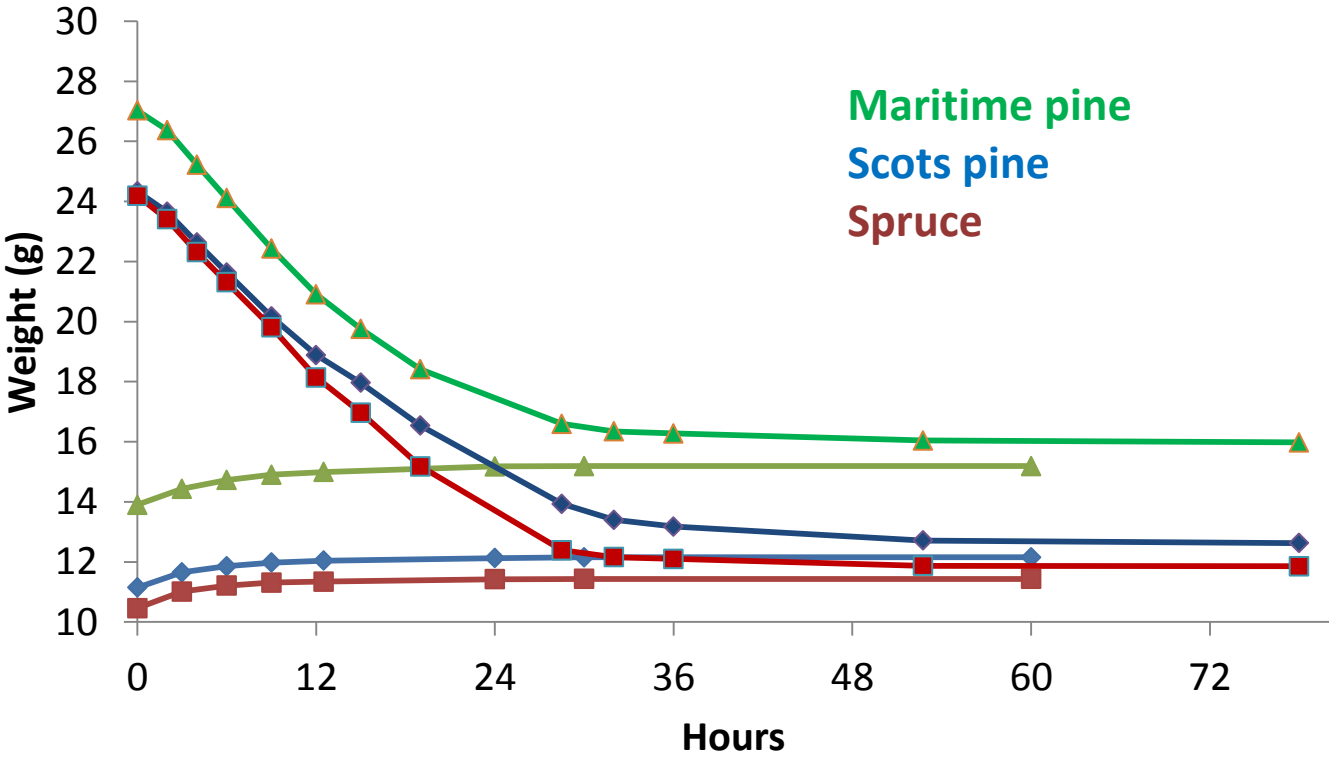
It was possible to assess the weight loss of each specimen for the three wood species,

To study the reliability of the values of the moisture content measured by the thermo hygrograph

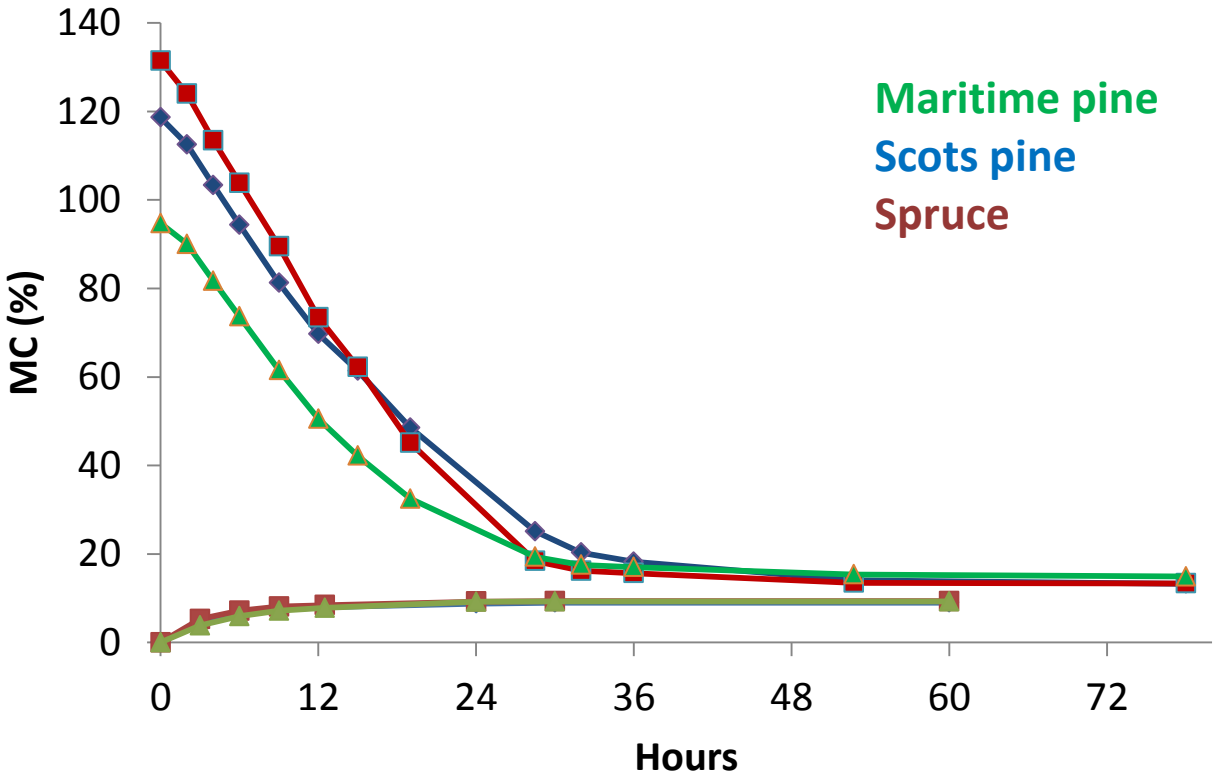
And, to quantify the equilibrium moisture content (EMC) of each wood species in both situations: desorption and adsorption



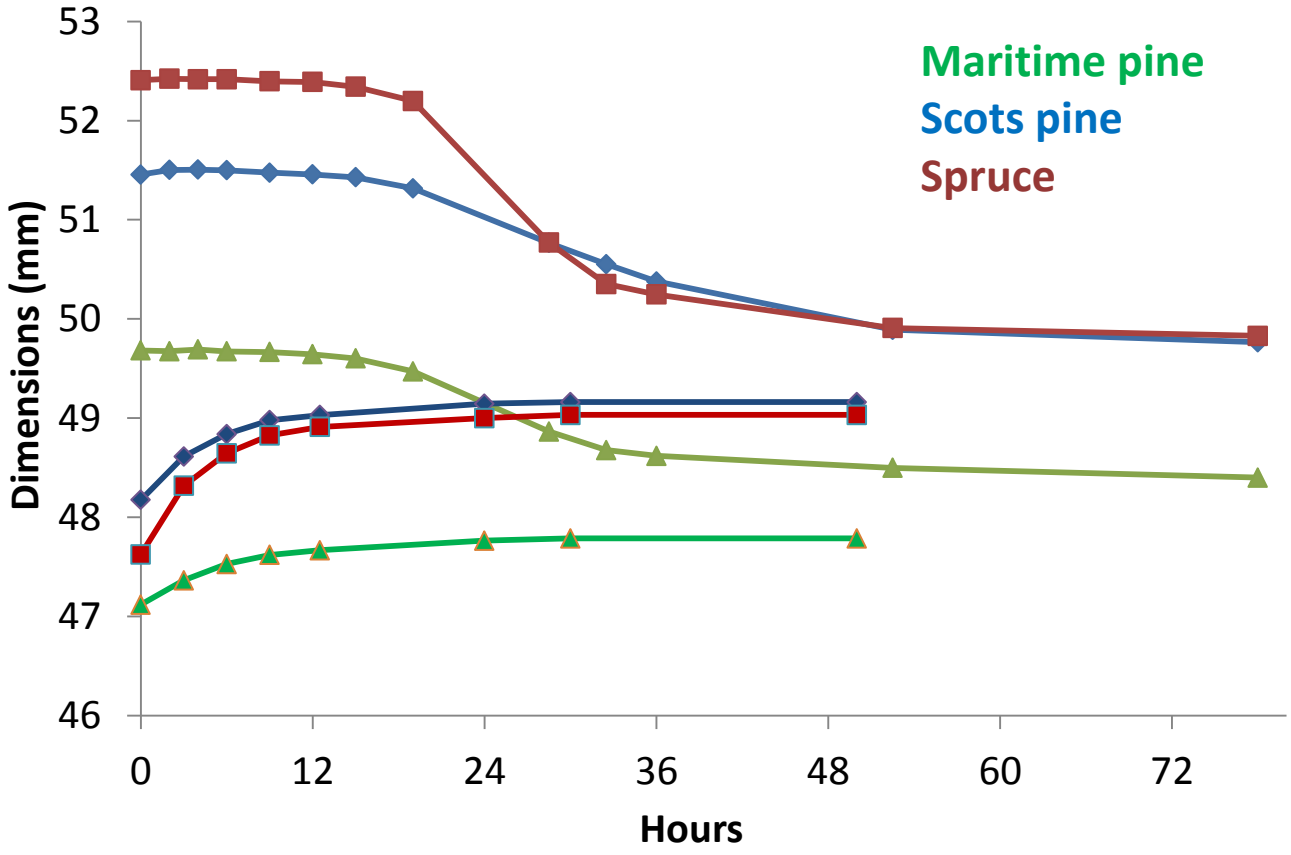
Results – Weight variation



Results – MC variation

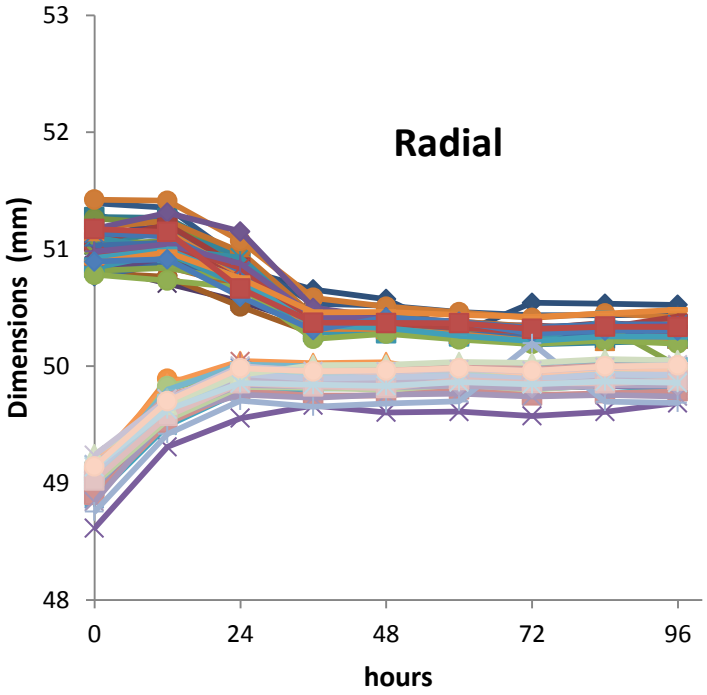


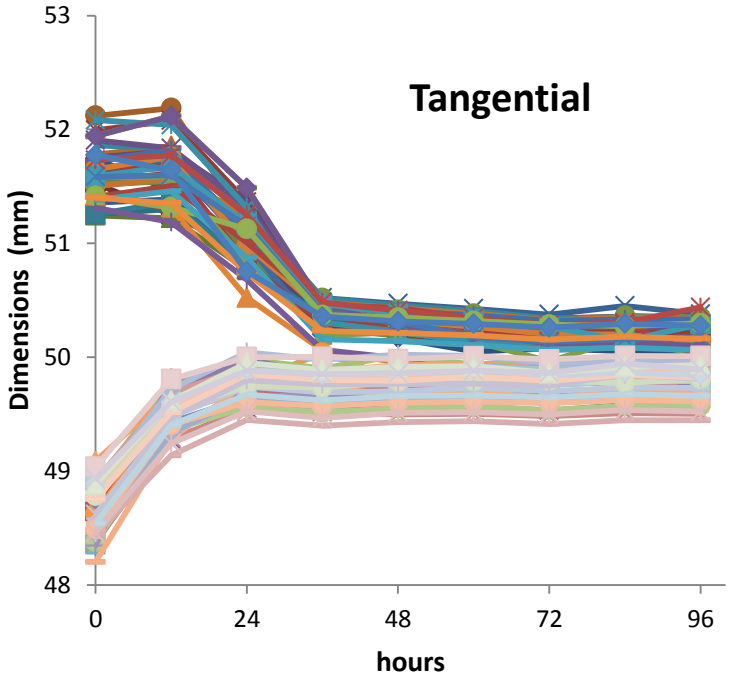
Results – Dimensions variation



Results – Anisotropic behavior (I)

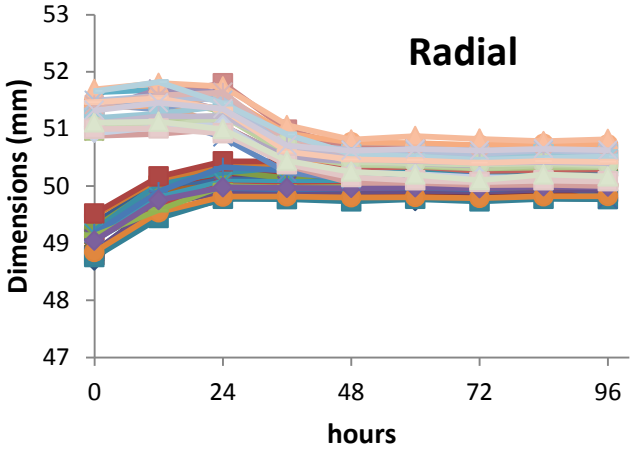
Scots pine

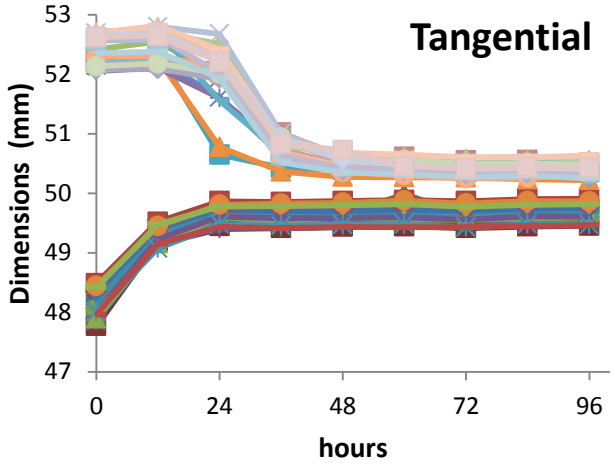




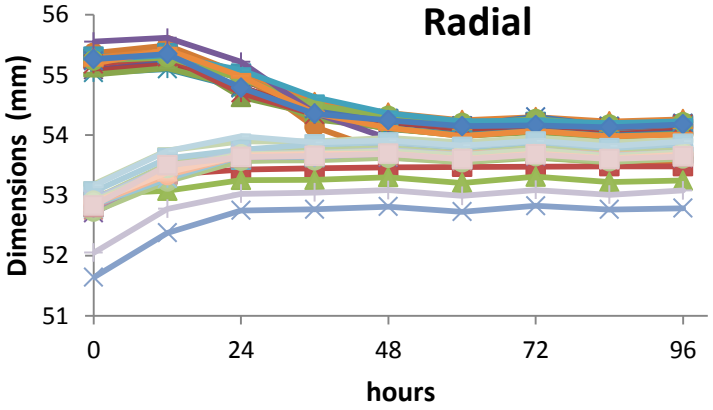
Results – Anisotropic behavior (II)

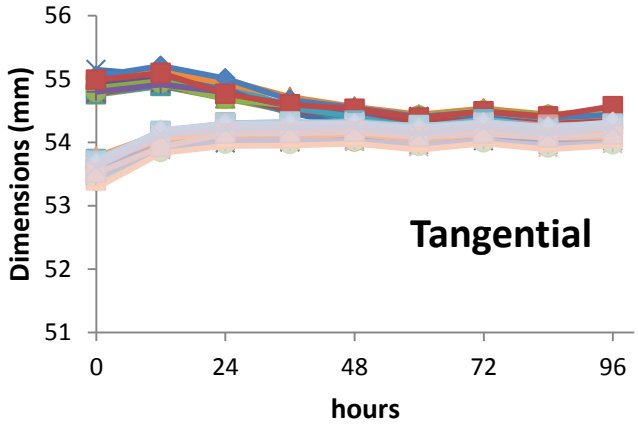
Spruce





Maritime pine





Results – EMC and Hygrometer effectiveness

EMC (%)	Hygrometer EN 13183-2	Oven dry EN 13183-1
Scots pine	8,8	11,7
Maritime pine	9,0	10,1
Spruce	8,0	10,2

Results – Summary

Wood Specie	Total of Specimens	Shrinkage (%)		Sweeling (%)		EMC (%)
		Radial	Tangential	Radial	Tangential	
Maritime pine	80	1,08	2,35	1,19	1,67	11,7
Spruce	60	1,17	2,95	1,23	2,80	10,1
Scots pine	80	1,44	2,86	1,72	2,22	10,2

Conclusions

✓Most important dimensional variation occurs within 24 hours

✓ Dimensional variations higher in the tangential direction

✓ Spruce presents the higher dimensional changes (tangential)

✓ Maritime pine is the more stable

✓ It is necessary to be aware of the lack of precision of Higrometers (in-situ measurements)

Thank You for the attention…

Kiitos!

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