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VISCOELASTIC AND MECHANO-SORPTIVE BEHAVIOUR OF TWO TROPICAL SPECIES

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ABSTRACT: This document focuses on the study of viscoelastic and mechano-sorptive behaviour of the following tropical species: *Aucoumea klaineana* Pierre (okume), and *Pterocarpus soyauxii* Taub (padouk). The specimens were tested in 3-point bending under mechanical load and constant temperature at different relative humidity cycling from 40 to 75% for 14 days. The specimens were tested at a low stress of 10% of the ultimate tensile strength. Control specimens of the species were also placed in the box for moisture content monitoring by mass weighing. The deflection is measured by linear LVDT transducers. The results of this work show how the strains increase as a viscoelastic effect and how the strain id increased by the mechano-sorptive effect. It has also been observed that the humidification phases cause a decrease of the strain except during the first humidification, unlike the drying phases which increase the strain.

KEYWORDS: Viscoelastic, Mechano-sorptive, Tropical species, 3- point bending, Moisture content

1 INTRODUCTION

The mechanical properties of wood are considerable affected by the interactions of outdoor conditions and mechanical loads [1]. For wooden structures subject to these interactions over time, their service life is greatly reduced [2]. Wood by its polymeric nature has the characteristics of a viscoelastic material, this behaviour depends on temperature, and on the mechanical loading level [3]. Viscoelastic behaviour can be demonstrated by creep tests in a constant climatic environment [4]. When the effects of climatic variations (relative humidity) under constant mechanical load are added to viscoelastic behaviour, wood exhibits another more complex behaviour called mechano-sorptive behaviour.

Today there are very few studies on viscoelastic and mechano-sorptive behaviour of tropical species. This paper presents the experimental results of the viscoelastic and mechano-sorptive behaviour of two tropical wood species with different densities. The tests were carried out over 14 days at the University of Florence.

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2 MATERIAL AND METHODS

Series of viscoelastic and mechanical tests are carried out over 14 days under a relative humidity cycle of 40, 65and 75% on specimens of okume and padouk.The density of the specimens tested is 0.48 for okume and 0.79 for padouk and have the following dimensions (L=160mm, T=12mm, R=6mm Fig. 1). The load applied to these specimens is 10% of the rupture load.

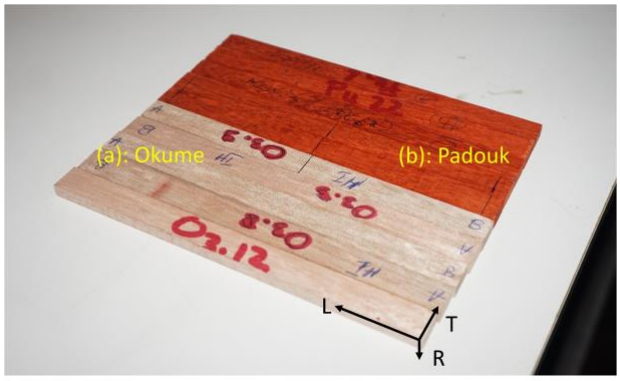

***Figure 1**: species tested (a): okume (b): padouk*

The experimental set-up consists of two mini 3-point bending creep test benches posted in Fig.2. For these benches the distance between the two supports is 150 mm. The benches are placed in a box where relative humidity is regulated. Each test bench is equipped with 3 LVDT linear transducers, (i) one in the center (T2 or T5) to measure the total deflection; (ii) two in way of the lower supports (T1, T3) or (T4, T6) to correct the central

deflection measurement and measure the swelling shrinkage. For these tests, the maximum load applied to specimens is 10% of their breaking strength, 3.5Kg for okume and 5.6Kg for padouk. These different loads were defined by executing static tests until failure. The box is equipped with two relative humidity sensors, one for the regulation and one for monitoring. In order to evaluate the moisture content of the specimens tested, 4 control specimens of each tested species were also placed inside the box in order to determine the moisture content of the speciemens by mass weighing. Fig.3 shows the evolution of moisture content (MC) of the specimens and RH of the box measured by the thermo-hygrometer. The test and the mass tracking of padouk had begun 14 days after those of okume.

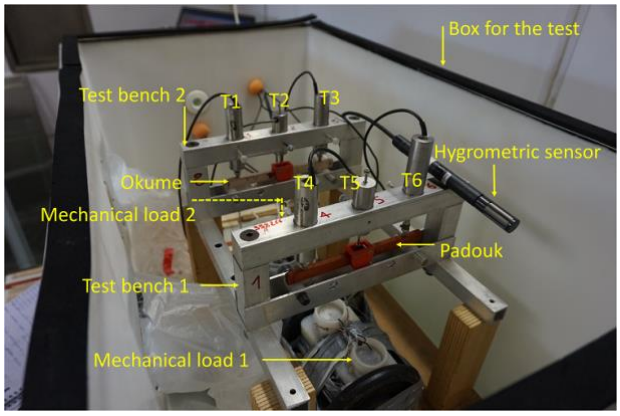

***Figure 2**: experimental set up for voscoelastic mechano-sorptif test*

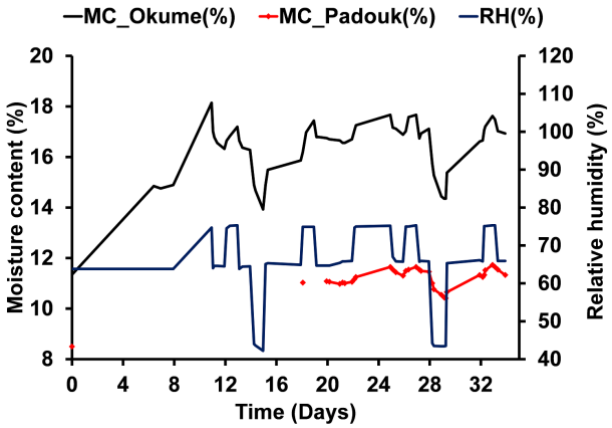

***Figure 3**: Moisture content of the matched beams in the box*

3 RESULTS

Fig.4a describes the behaviour observed on okume specimen during the constant stress and after discharge (Fig. 4b). In Fig. 4a we can firstly observe between a_0 and a_1 an instantaneous strain ε_{elas} due to the elastic behaviour of the wood. Then a delayed increase in deformations ε_{visc} due to the viscoelastic effect. After the first humidification, a significant increase of strain is observed, it can be explained by the mechano-sorptive effect ε_{meca}. It is this same effect that explains the evolution of these strain during the first 11 days of the test between a_2 and a_3. After the first humidification, which leads to an increase of strain, we notice that the subsequent humidification phases lead to a decrease of strain. When a drying phase never reached before in the draft shield is reached (6th and 8th days 40% RH) we can see that there is a significant increase in deformation. During discharge, there is an instantaneous recovery between a_3 and a_4 and a small partial recovery phase between a_4 and a_5. After humidification, there is a delayed onset of recovery between a_5 and a_6.

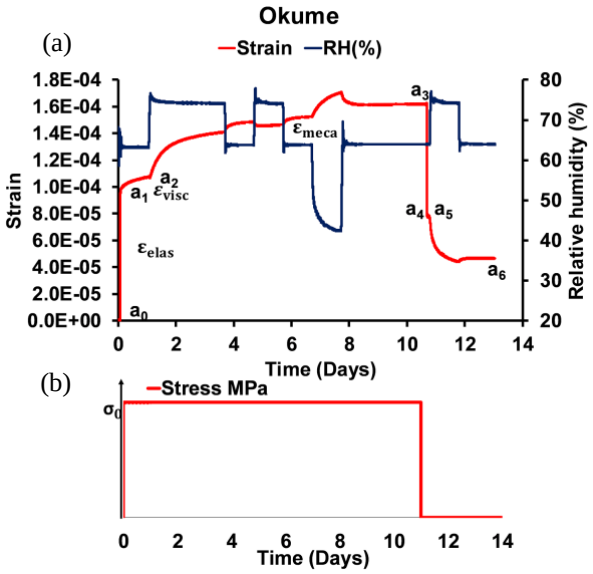

***Figure 4** :(a); Viscoelastic and mechano-sorptive test on okume (b); Stress*

4 CONCLUSION

The behaviour of the two tropical specimens highlights the mechano-sorptive and viscoelastic effects of the latter for low stresses. It has been observed that strain decreases during the humidification phases except during the first humidification. And that the drying phases causes an increase of the strain. A further test phase is planned on the notched specimens. This test phase will allow us to more easily decouple the contribution of the material's behaviour under climatic variation from that of the rupture to the beam deflection.

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