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Investigation of tropical wood modification under hydro-mechanical loadings with digital image correlation and X-ray microtomography

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Wood-basedmaterials are very sensitive to the effects of climatic loadings (temperature and hydric variations), during their service life. In this case, the wood modification due to these impacts can also compromise the durability of timber structures. The present work investigates the cracking of tropical species from the Gabonese forest, such as *Milicia excelsa* (Iroko)*, Aucoumea klaineana* (Okoume) *and Pterocarpus soyauxii* (Padauk), in order to improve their sustainability. The experimental setup is composed of an electronical testing machine (Fig. 1 b), a wooden specimen (Fig. 1 a) with an Arcan steel system (the set constitutes the Mixed-Mode Crack Growth or MMCG developed by Moutou Pitti *et al.* 2011) is presented.

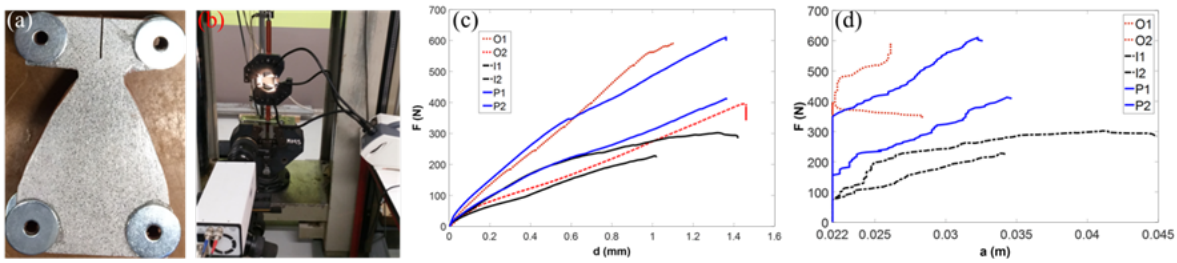

Figure 1: Wood MMCG specimen (a); experimental setup (b); load-displacement curves (c); load-crack length curves (d).

The displacement fields (Fig. 1 c) and deformation are measured by the Digital Image Correlation (DIC) method (Méité *et al.* 2013). The advance of the crack tip at different loading stages is recorded (Fig.1 d). These results are obtained from the displacement and strain maps (Fig. 2) given by the camera (Fig. 1 b). Preliminary results show important information about the fracture toughness of these tropical woods in constant and variable environments. Simultaneously, in order to follow the three-dimensional crack growth process of these tropical species, the X-ray microtomography

(XMT) method is performed (Mayo *et al.* 2009). Fig. 3 (a) and (b) show the 3D image acquisition protocol by MXT.

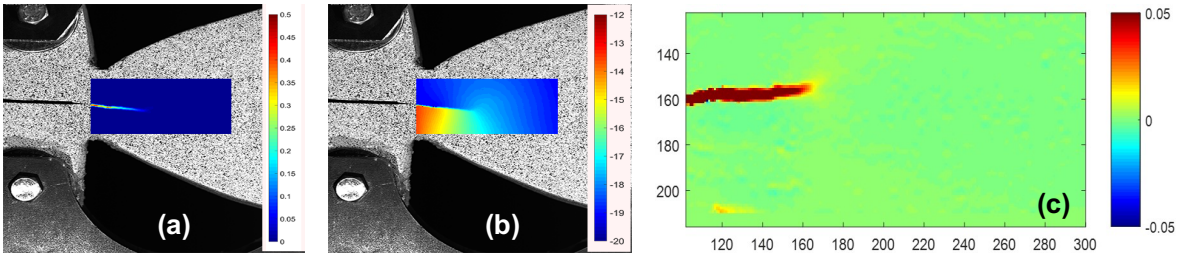

Figure 2: Displacement maps (a); strain maps (b); Crack evolution (c).

The tested specimen is cut according to the direction of cracking initiated by a pre-cut of 22 mm (b). The wood sample to be scanned is then introduced into the microtomograph chamber (b). After reconstruction, a 3D volume is obtained from several 2D scans at 4 µm resolution (Figs. 3 (c) and (d)). Images on healthy and cracked samples were taken under dry and wet conditions, respectively. Fig. 3 (d) shows the ability of the MXT to detect and track internal crack growth in tropical timber.

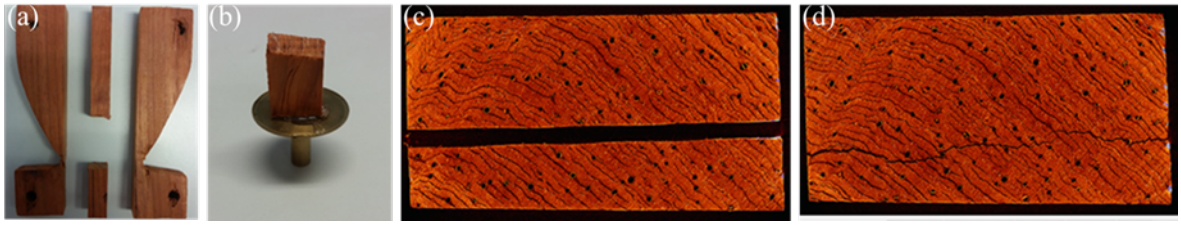

Figure 3: Image acquisition protocol by: (a) - scanned specimen; (b) - 3D cross-section of Padouk under wet conditions: specimen with a 22 mm pre-cut; (c) - crack path (d).

In the coming works, the MXT method will be applied to study the impact of the density and the spatial variability details observed on Fig. 3 (c) and (d) on the mechanical behaviour of wood and wood modification.

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