A COMPARATIVE STUDY ON THE CRACKING OF TROPICAL WOOD SPECIES BY THE GRID METHOD

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Abstract: The present study focuses on the cracking of tropical species from the Gabonese forest such as Milicia excelsa (Iroko) and Pterocarpus soyauxii (Padouk). The critical energy release rate is computed with a modified Mixed Mode Crack Growth (MMCG) specimen in opening mode (mode I). An electromechanical testing machine and an Arcan fixture are used in order to apply the load to the specimen. The force-displacement curves, the crack growth process as well as the opening crack are deduced from the recorded images. These images are processed by the grid method. The energy release rate is estimated by the compliance method. The results are given for the two wood species and two different specimen thicknesses. We conclude that the thickness has an influence on the energy release rate that is estimated.

1. Introduction

The Gabonese forest is a part of Congo Basin and is the second largest forest in the world after the Amazon. However on the ground wooden structures are very negligible. The present work is to study the behavior to cracking of tropical species. This work is focused on the crack growth process in opening mode of the Iroko and of Padouk species using MMCG specimen [1]. Specimens are mounted in an Arcan system and placed in an electromechanical testing machine. A CCD camera records images during the test. Pictures are processed by the grid method [2]. They enable us to measure the opening and the length of crack during the tests. The values of the evolution of the energy release rate will be calculated and presented.

2. Results

The wood specimens' with dimensions (Lxhxb) 105x70x15 mm^3 are tested, Fig. 1 (a). The initial crack, with length a_i = 22 mm is machined along the longitudinal direction (L) (see Fig. 1 (b)). On one face of the specimen, a grid of pitch 200 µm is deposited, see Fig. 1 (b). The values of the densities of these wood, to know, the Iroko and the Padouk are respectively of 0.64 and 0.79. The room temperature (T) is 21 °C and the relative humidity (RH) is 35%.

Four washers in galvanized steel of a diameter of 6 mm were used to reinforce the holes, through which the load was applied, as shown if Fig. 1 (c). The lower and upper parts of the specimen have also been reinforced by thin aluminum plates. The camera was placed at 675 mm of the specimen in order to record pictures. Displacement and strain fields were deduced from the images using the grid method. The MMCG specimen and the experimental device are presented on Fig. 1 (c).

The observation of the different curves of Strength-displacement show that the strength at break of is Padouk twice superiors to those of Iroko. The critical load of Padouk reach almost F_{RP}=1400N, while those of Iroko are almost half, just under F_{RI}=600N. Similarly, of the strengths of Padouk produced of lower displacements $0.4\ mm$ while of Iroko strengths induce a higher displacement $0.6mm$.

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Regarding the energy release rate we observe that Padouk values are also higher than those of Iroko. Indeed, for the Padouk we have: $G_C = 266J/m^2$ and $G_C = 415J/m^2$. For Iroko we get the values of $G_C = 192J/m^2$ and $G_C = 265J/m^2$. These are the values at break. These results clearly show that break the Padouk requires more energy than break Iroko. For calculations of the critical energy release rate, the compliance method in imposed displacement was used, see equation 1.

$$G_c = \frac{F_C^2}{2 \cdot b} \cdot \left(\frac{\Delta C}{\Delta a}\right) \tag{1}$$

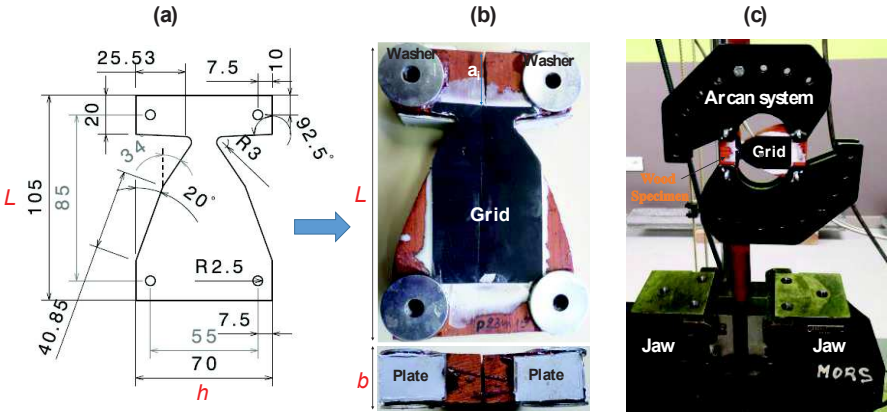

Figure 1. dimensions of specimen (a); side of crack initiation and face with grid (b), experimental device (c)

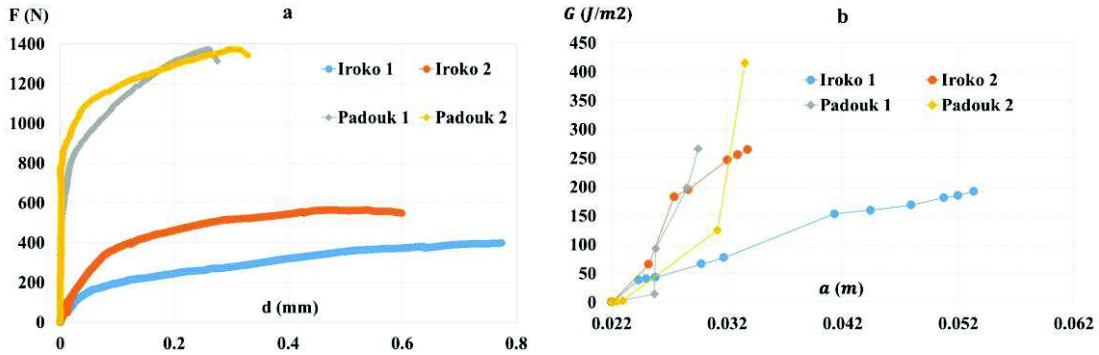

Figure 2. Force-displacement curves (a) and critical energy release rate- crack length curves (b)

3. Conclusions

In this work, the tests were performed on Iroko and Padouk tropical species with MMCG specimen for different thicknesses and densities. By using the grid method, the crack opening and the crack growth process are obtained. The energy release rate calculations presented show that bigger the material is dense, bigger is value of the critical energy rate at break. Also, the energy release rate increase proportionally to the thickness of wood specimen.

References

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Acknowledgement
The authors would like to thank the AUGC (Association Universitaire de Génie Civil) for his financial support of this work.