



## **BONDING PERFORMANCE OF TROPICAL MULTI SPECIES GLUED SOLID TIMBER**

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### **► To cite this version:**

Cedric Horphe Ndong Bidzo, Rostand Moutou Pitti, Samuel Ikogou, Kaiser Beat, Claude Feldman Pambou Nziengui, et al.. BONDING PERFORMANCE OF TROPICAL MULTI SPECIES GLUED SOLID TIMBER. World Conference On Timber Engineering, Aug 2021, Santiago, Chile. <hal-03042576>

**HAL Id: hal-03042576**

**<https://hal.science/hal-03042576v1>**

Submitted on 6 Dec 2020

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# BONDING PERFORMANCE OF TROPICAL MULTI SPECIES GLUED SOLID TIMBER

Cédric Horphé Ndong Bidzo<sup>1</sup>, Rostand Moutou Pitti<sup>2,5</sup>, Samuel Ikogou<sup>3</sup>, Beat kaiser<sup>4</sup>, Claude Feldman Pambou Nziengui<sup>3</sup>, Evelyne Toussaint<sup>2</sup>, Serge Ekomy Ango<sup>5</sup>

**ABSTRACT:** This paper investigates cracking in mode I of tropical multi species glued solid timbers. The objective is to assess the influence of the resistance of glue joints on such assemblies. Specimens are tested in Double Cantilever Bending (DCB), and a crack is initiated on the glue joint to facilitate the delamination under a quasi-static loading. The objective is to determine the stress intensity factor and the energy release rate, but also to study the propagation of the crack according to the load using a full field measurement technique. Three tropical species with different density, are chosen and glued by pair in order to lower the cost of the Glued Solid Timber (GST) beams. The adhesive used is a Phenol Resorcinol Formaldehyde (PRF) associated with a hardener HRP-155.

**KEYWORDS:** Tropical species, Glued Solid Timber, Cracking, Stress intensity factor, Energy release rate.

## 1 INTRODUCTION

The stabilization of environmental effects, harmful to our environment, today requires the preservation of tropical forests such as that of Gabon in the Congo Basin, which is one of the true lungs of the planet. One solution is to maximize the mechanical strength of the currently debited species by incorporating lower quality ones into the GST structures in order to sustain service structures. This technique minimizes losses due to sawing, maximizes the mechanical strengths of the structural elements obtained and, therefore, allows to control the costs of wood construction still considered high in view of the immense resource's forests available to the country. Previous studies have already shown the feasibility of using composites glued from tropical woods and also that GST resistance depends on the position and the density of individual lamella or DUO or TRIO combinations met structural requirements [1,2].

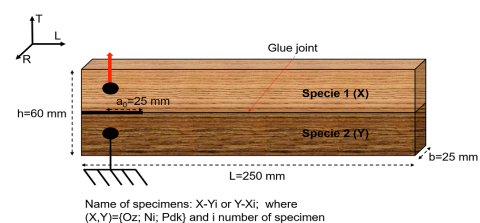
It should be noted, however, that for any glued composite element (GST, GLT, CLT), the integrity and the strength of the glue joints are a basic prerequisite for the structure [3], in addition to the physical properties of the wood and the bonding parameters (glue spread pressure applied, pressure time) that have an influence on the strength of

glue joints. In this study, three tropical species are chosen, namely *Staustia Kamernesis* (Niové), *Dacryodes Buettneri* (Ozigo) and *Pterocarpus Osun* (Padouk).

This paper investigates the fracture toughness in pure opening mode I of glue joints, Double Cantilever Beam (DCB) specimens taken from GST beams. The main objective is to determine the cracks parameters such as the stress intensity factor of the glue joints and the critical energy release rate.

## 2 MATERIAL AND METHODS

The DCB specimens have been glued and sized at Ecowood SA, specialized in tropical wood construction. Figure 1 illustrates the schematics and nomenclature. Niove, Ozigo and Padouk will be noted respectively Ni, Oz and Pdk in the specimen's nomenclature.



**Figure 1:** Schematization of specimens

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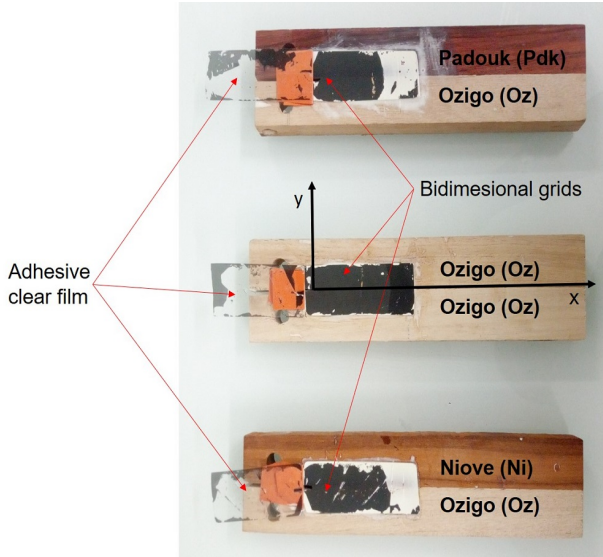
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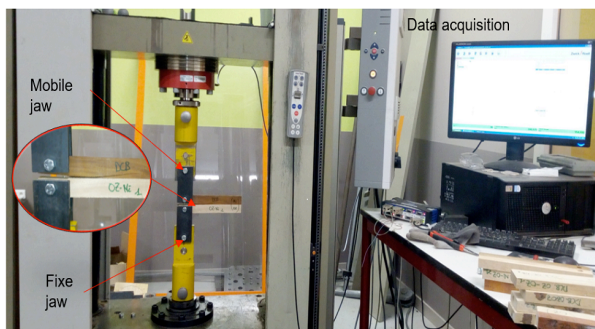
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The grid method [4] is employed to measure the in-plane displacement field on the front face of the specimens in order to detect and track the crack in glue joint during tests. In our case the grids were put along the glue joint as e.g. in Figure 2. This technique consists in processing images of a bidimensional grid transferred onto the specimen before testing in order to determine the displacement and strain maps. These images are then processed by using a Fourier-based technique in order to retrieve the displacement fields



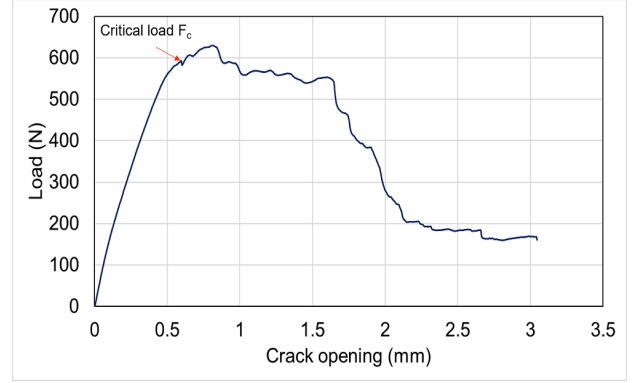
**Figure 2.** Specimens with bidimensional grid

A fine line made with a cutter was machined on the notch to facilitate delamination. The experimental device is composed of a 200kN "Zwick Roel" testing machine and high-resolution camera suitable for our specimens and a data acquisition system as e.g. in Figure 3.



**Figure 3:** Experimental device: Oz-Ni1 specimen testing

The crack opening is deduced from the displacement maps, two points located each on one of the opposite sides of the glue joint. These points sufficiently close to the crack, so that the difference between the vertical displacement measured at those points can be considered as the crack opening along the vertical line defined by these points. An example of the load-crack opening curve of Oz-Ni1 specimen is presented in Figure 3.



**Figure 3:** Crack Opening-Load curve of Oz-Ni1 specimen

The compliance method was used [4] to calculate the critical energy release rate and the stress intensity factor, as presented in Equations (1) and (3), respectively.

$$G_{Ic} = \frac{F_c^2}{2b} * \frac{\Delta C}{\Delta a} \quad (1)$$

$$\text{with, } \Delta C = \frac{U}{F_c} \quad (2)$$

$$K_{Ic} = (E * G_{Ic})^{\frac{1}{2}} \quad (3)$$

$F_c$  is the critical load which causes a crack length  $\Delta a$ ,  $U$  is the crack opening induced by the critical load  $F_c$  and  $\Delta C$  is the increase in compliance corresponding to the increase in crack length  $\Delta a$ .

## ACKNOWLEDGEMENT

The authors thank EcoWood SA society for the supply of wood and making of specimens, the PEPS CNRS project "RUMO", the Auvergne Rhône Alpes region (SCUSI Project) and the ASE Group Holding for supporting this study.

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