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Mechanical characterization of tropical glued solid timber beams

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ABSTRACT: This paper deal with the mechanical behavior of some tropical glued species. Three tropical species have been correctly selected from four criteria (threat of extinction, availability, resistance and job class). The goal is to manufacture glued solid timber beams from hardwood (*Staudtia kamerunensis* And *Ppterocarpus soyauxii*) and softwood (*Dacryodes Buettneri*), the adhesive used is at the phenol. The rupture module (MoR) and the modulus of elasticity (MoE) of four configurations are calculated and compare to the characteristics of soft wood. The results show the increasing in the strength and the stiffness of the beams made of *Staudtia kamerunensis* and *Dacryodes Buettneri* relative to the characteristics of the soft wood. While the characteristics of beams made up of *Ppterocarpus soyauxii* and *Dacryodes Buettneri* Slightly below the characteristics of the soft wood.

1 INTRODUCTION

In Gabon, forest covers about 85% of the territory. From the perspective of an emerging Gabon, the government has decided to ban the export of logs since January 2010, paving the way for local processing and extension of tropical species in local and sub-regional constructions (Ikogou et al. 2016). However, because of the operating costs related to primary processing and drying, the massive sawn timber used in construction are still very expensive. An alternative would be to use Glued solid timber (GST) and Glued Laminated Timber (GLT) from different species in order to minimize sawing losses, maximize the mechanical strength of the structural elements obtained and to control. Consequently, the costs of timber construction are considered high in view of the large forest resources available in the country.

Only GST, for example, are beneficial because of their technical, economic and ecological efficiency. They are mainly used in temperate countries in the construction of larges structures. Indeed, the current standards are written only for softwood species and the design and manufacturing recommendations rely on experimental tests on softwoods (Tran 2014).

In this study, three species of wood were reasonably selected through a multi-criteria analysis

in order to achieve the set objectives. The individual lamellae were characterized by three-point flexural tests. A phenol adhesive was used for binding the beams, the GST DUO and TRIO beams were characterized by three-point bending tests to study the different combinations.

2 MATERIAL AND METHODS

In order to perfectly glue the lamellae during the construction of reconstituted solid wood beams, the study was based on 40 species with a good ability to glue beforehand (CIRAD 2011). Four criteria were retained for the final choice of species: (i) the threat of extinction, (ii) the availability wood, (iii) the employment class and (iv) the mechanical resistance. Intra-criterion and inter-criterion weights were performed using a scale of 1 to 5

The results of the multi-criteria analysis resulted in the choice of *Dacryodes Buettneri* (Ozigo), *Staudtia kamerunensis* (Niové) and *Ppterocarpus soyauxii* (Padouk).

2.1 Preparation of specimens

The already dried wood was supplied and sized by Ecwood SA. The humidity of the wood was 17% for Ozigo and 14% for Padouk and Niové. The single

lamellae were first manufactured. The adhesive used for the binding was phenol ("Aerodux 185"). Before proceeding in the binding activity for the construction of the GST beams, boards were planed according to figure 1-a. to a final thickness of 20 mm for the TRIO and 30 mm for the DUO. The grammage (Fig 1b.) was done manually and on one side. The planks were stacked and put on the press with a pressure during 24h, with different combinations of the GST composed of numerous species (Fig. 1d)



Figure 1. Gluing process: (a) boards planed, (b) grammage, (c) Presse, (d) GST beams.

2.2 Methods

In this work, the tests were carried out on a UNITED testing machine fitted with a maximum load cell of 100 KN, the data were retrieved by the Datum software and processed on Excel. The tests were performed in a room with average temperature of 25°C and relative humidity of 65%. Before the test, the humidity of the specimens was reduced to 12 ± 4% in a climate chamber.

The three-point bending tests were carried out on single slats and the GST (fig. 2) was performed according to EN 408 (AFNOR 2009).

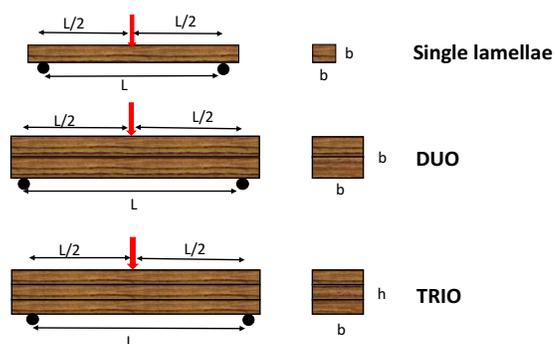


Figure 2. Different types of the tested beams on three-point bending.

3 EXPERIMENTAL RESULTS

For better follow-up of the test specimens during the data, the Niové is noted Ni, the Padouk Pdk and the Ozigo Oz.

The MoR and MoE averages were calculated for the singles lamellae and multi-gasoline RSWs, to determine the best DUO and TRIO combinations.

The strongest combinations were Ni-Oz and Ni-Oz-Ni with a MoE of (12476 MPa) and (14924 MPa) respectively. Brittle rupture was noted at the level of the Padouk lamellae and a ductile rupture on the slats of Niové. Table 5. Shows the values of the MoR and MoE of the various specimens tested.

Table 5. Values of experimental characteristics.

Specimens	Number	Humidity	MoR	MoE
		%	MPa	MPa
Ozigo	4	12.5	74	11746
Padouk	5	13	136	15614
Niové	5	13	133	18856
Ni-Oz	3	13.5-12.6	79	12476
Pdk-Oz	2	12.5-13	68	11013
Ni-Oz-Ni	3	13-12-12.3	111	14924
Pdk-Oz-Pdk	3	12.5-13-12.6	77	10183

4 DISCUSSION AND CONCLUSION

Niové, Padouk and Ozigo were classified into resistance classes D70, D65 and D35 in accordance with those of hardwoods of EN 338 (AFNOR 2016) standard. The TRIO Ni-Oz-Ni (14924 MPa) combination we obtain the most fracture toughness; it could be classified according to EN 14080 standard (AFNOR 2005) to belong to the highest resistance class (GL 32h). This configuration would be reasonable in the choice of structural use, as its characteristics are like that of hardwood (Padouk). It is pointed out, however, that by associating the Padouk (hardwood) and the Ozigo (soft wood), the resistance and stiffness of the beams (DUO and TRIO) tested is almost the same with that of the simple lamellae of Ozigo.

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