Full Characterization of Strength Properties of *Schizolobium amazonicum* Wood for Timber Structures

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***Abstract*-- *Schizolobium amazonicum* is a wood species whose growth results in small amount of defects, a good feature for its possible use as structural elements. So it is important to be aware of their strength properties. The aim of this research is the full characterization of *Schizolobium amazonicum* Wood aiming its employ in timber structures. Specimens were obtained using material came from Certified Area of Amazon Brazilian Forest, Pará State, Brazil. Tests were carried out with samples in standard conditions of moisture content (12%), according to Brazilian Normative Code ABNT NBR 7190: 1997. The following properties were determined: strength in compression and tension parallel to the grain; compression and tension perpendicular to the grain; embedment parallel and perpendicular to the grain; strength in shear parallel to the grain and specific gravity. It was possible to conclude that *Schizolobium amazonicum* can be considered as a C20 class Wood (dicotyledonous) and used for structural purposes.**

***Index Term*-- Full characterization; timber structures; *Schizolobium amazonicum* Wood.**

I. INTRODUCTION

Wood has been used as a raw material for several centuries for housing construction, roofing and structures such as bridges and walkways to overcome natural obstacles. Besides being a sustainable product, for presenting great absorption and fixation of carbon dioxide during its production, wood is easy to work and requires low power consumption in its processing. Currently, it is used in construction formwork and shoring from the roof structures, window frames and floors. For their proper use is necessary to know its properties of strength, stiffness and anisotropy due to its characteristics and variability [1].

The characterization of wood and is an important factor determining its end use. Being a biological material, wood has different physical and mechanical inter and intraspecific properties, being, then requires the characterization and classification of this material suitable for their best performance in use before the requests required. Many of the problems found in timber structures currently originate from improper use of the wood due to lack of knowledge about the material and the use of building techniques inadequate [2].

One of the main characteristics of the wood, which interferes in their properties, is its susceptibility to changes in moisture content due to the environmental conditions, i.e., the material hygroscopicity [3]. Grain Saturation Point can assume variable values depending upon wood species and ranges from 22% for conifers with high resin content up to 35% for hardwoods with high porosity in the sapwood. Below the mentioned point, major changes in the physical and mechanical properties of wood [4].

Brazilian Association of Technical Standards (ABNT) in its normative document ABNT NBR 7190: 1997, so-called "Design of Timber Structures" [5], defines three different ways to perform wood characterization: full, minimum simplified. In all cases, laboratory tests must be carried out according to Annex B "Determination of the properties of wood for projects of structures" of ABNT NBR 7190: 1997 [5].

Brazilian Amazon Forest region presents huge contingent of forest species still undiscovered. *Schizolobium amazonicum*, Amazonian species of great economic potential, has gained more prominence among species reforested in Brazil, because it has height and diameter increments that allow its use in a few years. *Schizolobium amazonicum* presents facilities regarding the removal of the bark, laminating, drying, pressure and excellent finish [6, 7].

In tests for determine the creep coefficient and compression parallel to grain strength of *Schizolobium amazoncium*, the influence of moisture content on their properties were studied, where we observed a decrease in strength and stiffness properties for specimens with moisture content above the standard (12%) [8].

Schizolobium amazoncium Wood species has great potential in the production of Glued Laminated Timber (GLULAM) due to its good adhesion with the adhesive and low specific gravity [9, 10, 11].

Schizolobium amazonicum presented compatible bending properties (modulus of rupture and modulus of elasticity) when compared with *Eucalyptus saligna* and *Pinus taeda* Laminated Venner Lumber (LVL) panel [12].

Studies about the physical, chemical, mechanical and veneers surfaces properties of *Schizolobium amazonicum* concluded that the veneers possess high porosity, low dimensional stability, low surface roughness and high wettability. Moreover, they found a correlation between the dynamic modulus of elasticity of veneers and specific gravity of the wood [13].

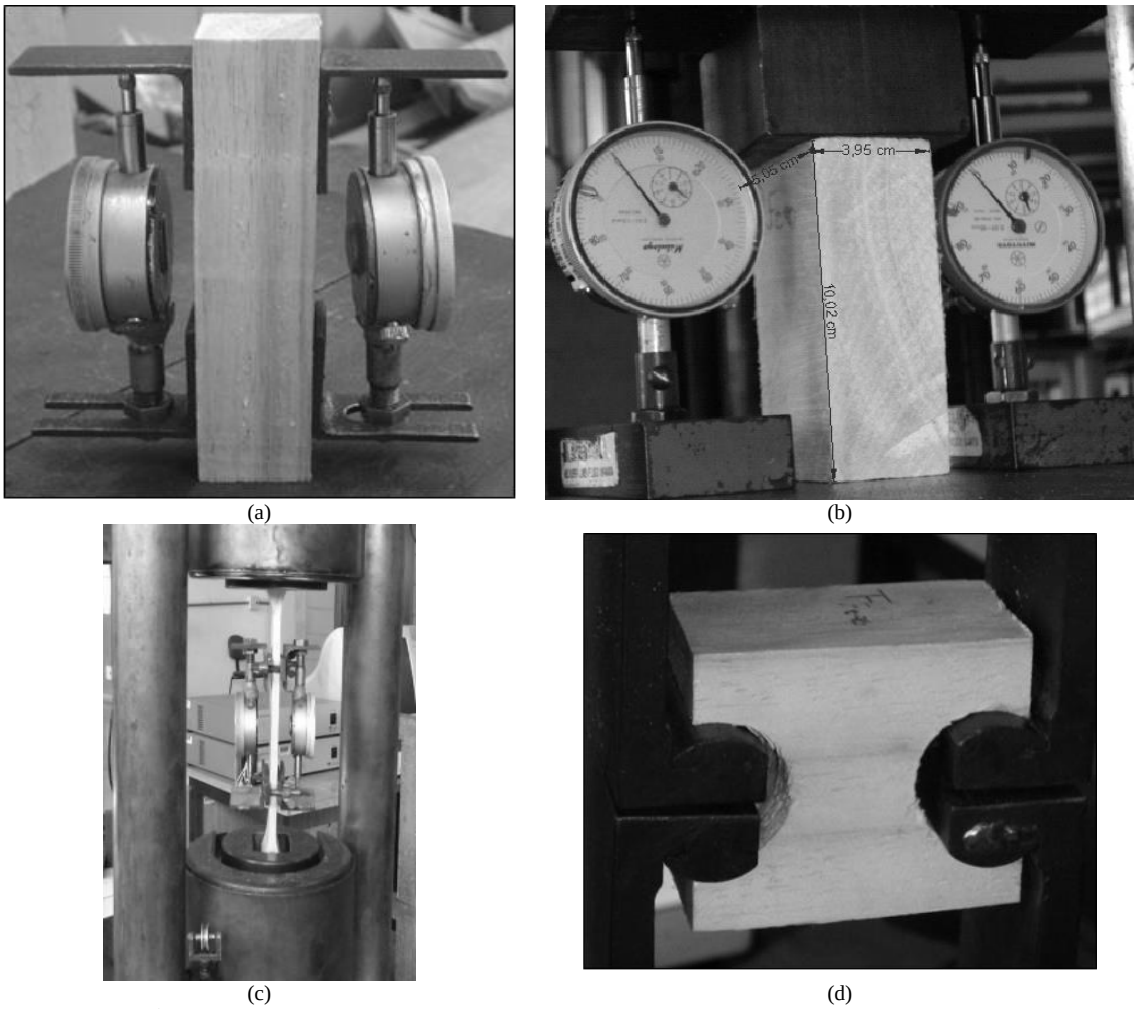
Schizolobium amazonicum, as a species of low natural durability, is susceptible to attack by wood decay agents, which requires its wood preservative suitable for their best performance in use [9, 14, 15]

Few studies with *Schizolobium amazonicum* were performed in order to determine their mechanical properties necessary for its use as a structural element in wood structures. The aim of this research is realize the full characterization of the strength properties of *Schizolobium amazonicum* for structural purposes.

II. MATERIALS AND METHODS

For the present study we used 10 years old pieces of *Schizolobium amazonicum* Wood from the Certified Area of Brazilian State of Pará. Specimens were fabricated with dimensions and characteristics in accordance with Annex B of ABNT NBR 7190: 1997 [5], in order to perform the following mechanical and physical tests for full characterization of the *Schizolobium amazonicum* Wood :

- Compression parallel to grain strength (f_{c0}) (Figure 1);
- Compression perpendicular to grain strength (f_{c90}) (Figure 1);
- Tension parallel to grain strength (f_{t0}) (Figure 1);
- Tension perpendicular to grain strength (f_{t90}) (Figure 1);
- Embedment parallel to grain strength (f_{e0}) (Figure 2);
- Embedment perpendicular to grain strength (f_{e90}) (Figure 2);
- Shear parallel to grain strength (f_{v0}) (Figure 2);
- Specific gravity (ρ) (Figure 2);



(a) (b) (c) (d)

Fig. 1. Instrumented specimens for (a) parallel to grain compression, (b) perpendicular to grain compression, (c) parallel to grain tension and (d) perpendicular to grain tension.

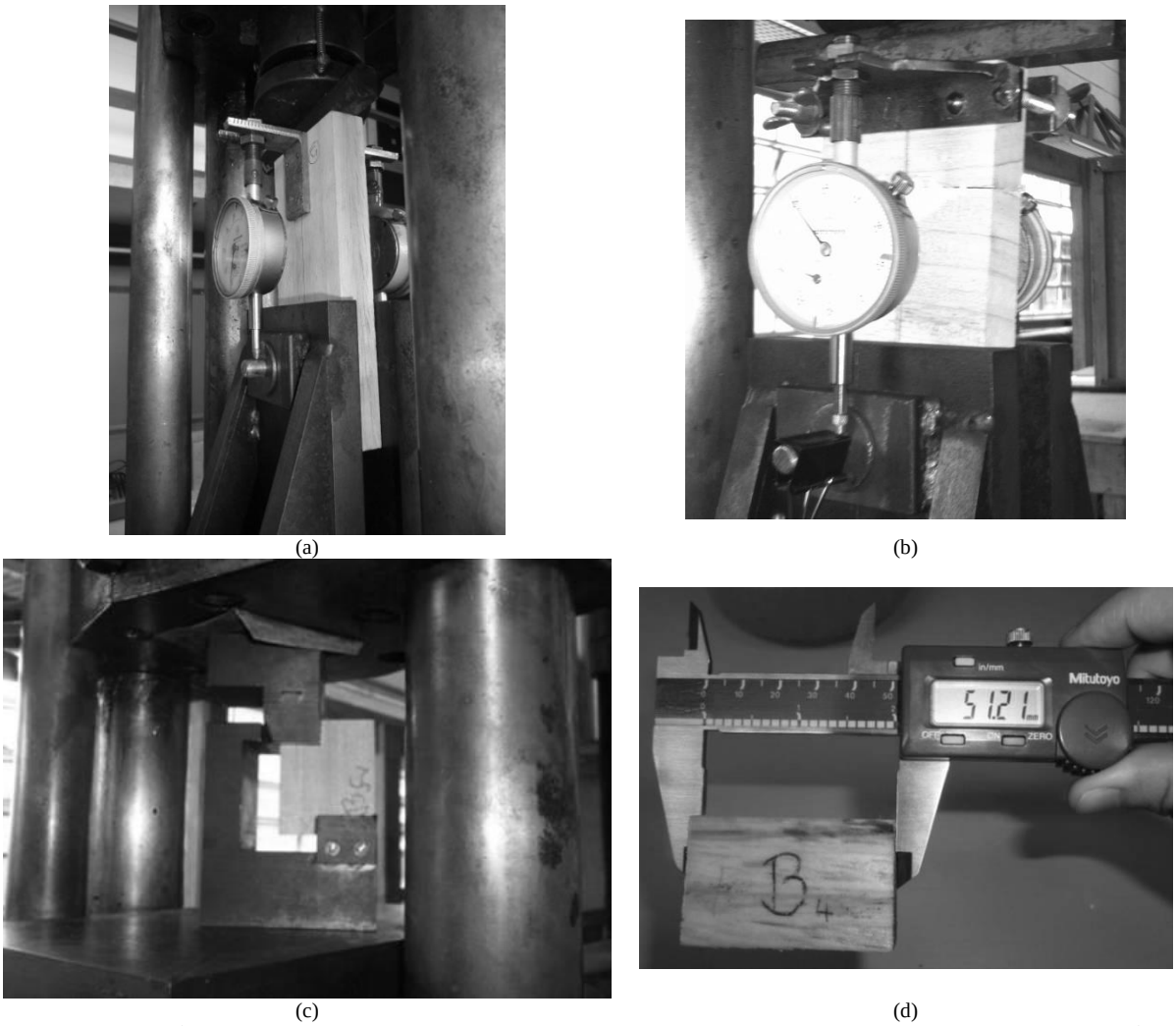


Fig. 2. Instrumented specimens for (a) parallel to grain embedment, (b) perpendicular to grain embedment, (c) parallel to grain shear and (d) specific gravity tests.

According to Brazilian Standard Code [5] characteristic values of strength were obtained of using Equation 1.

$$f_k = \left(2 \cdot \left(\frac{f_1 + f_2 + \ldots + f_{\frac{n}{2}-1}}{\frac{n}{2} - 1} \right) - f_{\frac{n}{2}} \right) \cdot 1{,}1 \quad (1)$$

Where: f_k is the characteristic value of strength, n is the number of specimens used and their respective results of strengths must be placed in ascending order $f_1 \leq f_2 \leq \ldots \leq f_n$, despising the highest value is the number of specimens is odd, not taking f_k to less than f_1, or 70% of the average value strength.

III. RESULTS AND DISCUSSIONS

Specific gravity determined for wood Paricá was 0.30 g/cm³, using 30 specimens. Bianche et al. (2012) [16] and Macedo et al. (2012) [17] determined for *Schizolobium amazonicum* Wood specific gravity equal to 0.26 g/cm ³ and 0.28 g/cm ³, showing the heterogeneity of the physical properties of wood. According to Loureiro et al. (1997) [18], some Amazonian species present specific gravity density similar to *Schizolobium amazonicum* Wood, as the case of *Jacaranda copaia* D. Don Wood, *Joannesia heveoides* Ducke Wood and *Bixa arborea* Huber Wood.

Table 1 presents characteristic values of strength (f_k), the average values of strength (f_m), standard deviation (SD), coefficient of variation (CV) and also the number of specimens used for each test (n).

Table I
Average values of strength, standard deviation, variation coefficient, characteristic values of strength and number of specimens.

Strength (MPa)	f_{c0}	f_{c90}	f_{t0}	f_{t90}	f_{e0}	f_{e90}	f_{v0}
n	32	16	30	17	15	12	18
f_m	27	2,80	49	1,55	18	10	8
DP	6,24	1,06	23,27	0,70	4,30	1,40	1,84
CV (%)	21	40	49	47	25	14	24
f_k	21	2	35	1	12	9	6

The $f_{c0,k}$ value equal to 21 MPa according to Standard Brazilian Code [5] classified *Schizolobium amazonicum* Wood as a species class C20 of dicotyledonous timber strength. Vidaurre et al. (2012) [19] also found value of $f_{c0,k}$ near 20 MPa for the same species.

Regarding the shear strength parallel to the grain, *Schizolobium amazoncum* Wood has greater strength when compared to all species of the genus *Pinus*, available in Annex E "Average values usual of strength and stiffness of some native timber and forestry" of the ABNT NBR 7190: 1997 [5].

The tension parallel to grain strengths found to *Schizolobium amazonicum* Wood was, approximately, two times larger than the compressive strength parallel to grain thereof. f_{t0} value found for *Schizolobium amazonicum* Wood very close to the results of f_{t0} values of *Pinus bahamensis* and *Pinus hondurensis* (ABNT NBR 7190: 1997 [5]), even these species having higher specific gravities.

The embedment parallel and normal to grain strengths values were lower compared to those determined by Manríquez & Moraes (2008) [20] for *Schizolobium amazonicum* Wood tested at 20 º C. This is acceptable to the variability of wood properties and also by the fact that the authors have used the guidelines of the European Standard for the tests, which is different from the Brazilian standard, used in this work.

IV. CONCLUSIONS

Based on results obtained in this research, it's possible to conclude that *Schizolobium amazonicum* Wood can be considered as a C20 class wood specie (dicotyledonous) because its characteristic strength in compression parallel to grain characteristic is 21 MPa. So, this specie can be employed for structural purposes, if properly conducted chemical treatment against attack by wood decay organisms.

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