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Production of Structural OSB with Cajueiro (*Anacardium* sp.) and Amescla (*Trattinikia* sp.) - A Preliminary Study

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Abstract The purpose of this research is to demonstrate, in an original study, the potentiality of the use of Cajueiro (*Anacardium* sp.) and Amescla (*Trattinikia* sp.), two low density tropical wood species, for producing OSB (Oriented strand boards), structural panels that replace plywood for several building purposes. In those panels, wood strands can be disposed in a specific direction or in random distribution, in order to reach the desirable mechanical properties. In this case, the strands were oriented by a separator to generate layers in mass proportion 20:60:20 (outer, inner and outer layers). Then these pre-panels went to a pre-pressing to form the mattress. Finally, they were pressed at 100°C, by 10 minutes, under 4.5MPa pressure, using castor oil based bicomponent polyurethane resin as adhesive. They were produced eight panels (four with Cajueiro e four with Amescla), with nominal dimensions 350mm length, 350mm width and 10mm thickness. Results showed that these wood species can be used to produce OSB, mainly considering values obtained in mechanical tests, that are superior to OSB produced in Brazilian enterprises and can be classified as OSB/4, as recommended by European standard EN 300. Research should continue to be developed in order to reach more adequate performance in swelling and water absorption.

Keywords Oriented strand board (OSB), Cajueiro, Amescla, Alternative tropical wood species

1. Introduction

Utilization wood based products is increasing is all world, in spite of wood species are characterized by large differences in terms of chemical composition and anatomical constitution. These differences can cause defects, that´s why in several cases solid wood application can be limited. Some wood based products, as OSB (Oriented strand board), present interesting properties for structural purposes, as substitute of plywood in framework and composite beams [1-4].

Wood panels are made from plies or particles in different dimensions, glued all together by the use of resin, pressure and heat [5]. Wood panels are usually applied in furniture, building constructions (such doors, floors, sidings, among others) and package. In Brazil, the first enterprise to produce OSB was MASISA Inc, in 2002, nowadays it produces 350,000 m^3 per year [6]. For OSB production, industries can use wood of low quality and faster growing with no restriction for diameter and length of the logs.

In agreement with European standard EN 300 [7], OSB is a panel with several layers composed by wood strands that can be glued with different kind of adhesives [1, 2, 4]. In OSB, the wood strands can be disposed in a specific direction or in random distribution, in order to reach the desirable mechanical properties. In these circumstances, OSB panels can be used in building construction in applications previously cited.

The both wood species Cajueiro (*Anacardium* sp.) and Amescla (*Trattinikia* sp.) are typical from center-west from Brazil (States of Mato Grosso and Tocantins). These are medium density woods, similar to those from *Pinus* genus, the most commonly utilized for panel production. In that region of Brazil, wood industries usually employ these species in very small structures, furniture and package. Hence, the purpose of this paper is to demonstrate, in an original preliminary study (the first one referred to Cajueiro and Amescla for wood based products) their potentiality for structural OSB production.

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2. Material and Methods

For OSB production, in laboratorial scale, Cajueiro and Amescla strands were used. It has been followed the instruction set proposed by [8], among others. At beginning, wood battens were cut in small pieces with 90mm width and 45mm thickness. All these pieces were processed in a strand generator in order to obtain the strands. Around 20 kg of strands from each wood species were obtained.

Later, the strands were mixed together with castor oil base bicomponent polyurethane resin, once it had already showed high performance in increasing mechanical properties as is showed by [1], [6] and [8]. Each panel weigh around 1kg (density about 0,8g/cm^3, equivalent to the commercial boards).

Firstly, strands were oriented by a separator in order to form layers in the mass proportion of 20:60:20, shaping the panel. Then these pre-panels went to a pre-pressing to form the mattress. Finally, they were pressed at 100°C, by 10 minutes [9, 10], under 4.5MPa pressure.

They were produced eight panels (four with Cajueiro e four with Amescla), with nominal dimensions 350mm length, 350mm width and 10mm thickness. After the panel production, they spent 48 hours in a seasoned room, with the aim of let the resin curate.

From these panels, specimens were cut to be tested in order to determine some physical mechanical and physical properties, following the European standard EN 300 [7] prescriptions. Table 1 shows the dimensions and the number of specimens for each test (by panel).

Table 1. Tests made with OSB panels

Test	Initials	Width	Length	Sp
Bending Static	BS	50mm	250mm	4
Tension Parallel to Face	TP	50mm	50mm	4
Screw Pull Out (Surface)	PSS	75mm	150mm	1
Screw Pull Out (Top)	PST	65mm	115mm	1
Density	D	50mm	50mm	4
Thickness Swelling	S	50mm	50mm	4
Water Absorption	A	50mm	50mm	4

- Sp: number of specimen by panel produced.

All tests were carried out according the methodology of EN 300 [7] and its correlated documents. They were performed in Wood and Timber Structures Laboratory (LaMEM), Structural Engineering Department, São Carlos Engineering School, University of São Paulo; and in Civil Engineering Department, Federal University of Minas Gerais (UFMG).

2.1. Physical and Mechanical Properties

Density of the samples was obtained using Equation 1.

$$D = \frac{M}{V} \quad (1)$$

In Equation 1, M is the mass and V the volume of the specimens.

Thickness swelling (S) and water absorption (A) were determined (for 2 and 24h) in percentage, using Equations 2 and 3, respectively.

$$S = \frac{E_2 - E_1}{E_1} \cdot 100 \ \ (\%) \quad (2)$$

$$A = \frac{M_2 - M_1}{M_1} \cdot 100 \ \ (\%) \quad (3)$$

From Equations 2 and 3, E_2 is the specimen thickness after water immersion; E_1 is the thickness before the immersion, M_2 is the mass of the specimen after water immersion and M_1 is the mass before the water immersion.

The parameters obtained in the mechanical tests were the bending stiffness (Modulus of elasticity – MOE) and bending strength (Modulus of rupture – MOR), both in MPa. These variables were calculated by Equations 4 and 5.

$$MOE = \frac{(F_2 - F_1) \cdot L^3}{4 \cdot b \cdot t^3 \cdot (a_2 - a_1)} \quad (4)$$

$$MOR = \frac{3 \cdot F_{\max} \cdot L}{2 \cdot b \cdot t^2} \quad (5)$$

From Equation 4 and 5, L is the specimen span (mm), F_2 corresponds to 50% of the estimated maximum force (F_{max}), F_1 corresponds to 10% of F_{max} (N), a_2-a_1 are the displacements at 50% and 10% of F_{max} (m), b is the width (mm) and t is the thickness (mm) of specimen.

For tension parallel to face, the calculations was made by Equation 6, where a and b are the specimens widths in both directions.

$$TP = \frac{F_{\max}}{a \cdot b} \quad (6)$$

Finally, for the both tests of screw pull out (surface and top), force is given in N. All mechanical tests were carried out in a Universal Machine Amsler (250 kN load capacity).

3. Results and Discussion

3.1. Physical Tests

Table 2 shows the values for density for the panels OSB manufactured with Cajueiro and Amescla wood species, where SD is the standard deviation and CV is the coefficient of variation.

Table 2. Values of Density for OSB

Cajueiro	D (kg/m^3)	Amescla	D (kg/m^3)
Average	814	Average	805
SD	90	SD	114
CV (%)	11	CV (%)	14

We can see that the OSB panels from Cajueiro and Amescla presented analogue density. Both values are slightly higher than those found by [1], 742 kg/m^3, for OSB produced with *Pinus* sp.

As it could be expected, for both OSB is possible to observe a significant increase in thickness swelling and water absorption, from 2h to 24h of water submersion.

Tables 3 and 4 shows the values of swelling and absorption for the panels OSB manufactured with Cajueiro and Amescla wood species, respectively.

Table 3. Swelling and Absorption for Cajueiro

Cajueiro	S-2h (%)	S-24h(5)	A-2h (%)	A-24h (%)
Average	10	19	12	31
SD	4	6	5	6
CV (%)	40	32	42	20

Table 4. Swelling and Absorption for Amescla

Amescla	S-2h (%)	S-24h(5)	A-2h (%)	A-24h (%)
Average	13	24	16	40
SD	6	8	7	12
CV (%)	46	33	46	30

The values of thickness swelling and water absorption of OSB panels with Cajueiro are smaller than those with Amescla. It can be explained because Cajueiro presents high extractives quantity than Amescla, as pointed by [11].

These values permit to classify OSB with Cajueiro and Amescla strand as OSB/2, based on EN 300 (2006). OSB/1 is the type recommended to application in "load-bearing boards for use in dry conditions".

3.2. Mechanical Tests

The mechanical tests (static bending and tension parallel to face) were performed as described earlier. Calculations were elaborated using Equations 4, 5 and 6 to obtain the MOE, MOR and tensile strength parallel to the face (TP), respectively. Tables 5 and 6 presents the results of these properties for the Cajueiro and Amescla wood species.

Table 5. Values of MOE, MOR and TP for OSB from Cajueiro

Cajueiro	MOE (MPa)	MOR (MPa)	TP (MPa)
Average	8933	48	5
SD	4290	9	2
CV (%)	48	19	40

Table 6. Values of MOE, MOR and TP for OSB from Amescla

Amescla	MOE (MPa)	MOR (MPa)	TP (MPa)
Average	7576	39	4
SD	1169	9	1
CV (%)	15	23	25

It can be observed that the values of Cajueiro OSB panels were higher than the values found for OSB panels of the Amescla. The MOE values were close to the value found by [1] which was 8679 MPa for OSB panels of *Pinus* sp.

But the MOR value found by [1] was 60 MPa higher than the Cajueiro 48 MPa and 39 MPa for Amescla. But, in this research, TP values of 5 MPa and 4 MPa were higher than found for the OSB with *Pinus* sp. (2 MPa). It can be justified because *Shizolobium amazonicum* presents very small extractives quantity, aspect that makes viable the high performance of the resin employed.

These values permit to classify OSB with Cajueiro and Amescla strand as OSB/4, based on EN 300 [7]. OSB/4 is the type recommended to application in "heavy duty load-bearing boards for use in humid conditions", the higher one of the mentioned standard.

Tables 7 and 8 presents the results of screw pull out surface [PSS] and screw pull out top [PST].

Table 7. PSS and PST values for OSB Cajueiro

Cajueiro	PSS (N)	PST (N)
Average	521	415
SD	74	194
CV (%)	14	47

Table 8. PSS and PST values for OSB Amescla

Amescla	PSS (N)	PST (N)
Average	432	265
SD	88	95
CV (%)	20	36

Screw pull out mean values were greater for OSB panels with Cajueiro compared with Amescla panels. Both of them were lower than the values found by [1] which was approximately 1500 N for OSB panels of *Pinus* sp. It was not possible identify physical reasons for these differences.

4. Conclusions

Even considering the pioneering character of this first study involving the tropical wood species (Cajueiro and Amescla), it's possible to conclude that both of them are viable for employing in OSB manufacturing, in laboratorial scale. Results show a very interesting mechanical performance of the panels, with a consequent possibility of classify them as OSB4, based on correspondent requirements of EN 300 [7].

Obviously, the research must be developed in order to reach more adequate performance in swelling and water absorption.

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