A Preliminary Study about the Utilization of Cajueiro and Amescla for MDP Panels Production

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Abstract The most commons woods used for production of medium density particleboard (MDP) are Eucalyptus and Pinus. The Cajueiro and Amescla wood are typical trees coming from the center-west of Brazil, from the States of Mato Grosso and Tocatins. These are medium density woods similar to Pinus sp, the Brazilian’s wood’s industries usually used these woods only as piece of wood for structures or furniture. The purpose of this research is to investigate, in a preliminary study, the possibility of MDP panel’s production using Cajueiro and Amescla wood species. The panels were produced under a pressure of 4 MPa for 10 minutes at 100 °C, and it was produced a total of 12 MDP panels, 6 of Cajueiro and 6 of Amescla, with a thickness of 10mm, dimensions 250mm×250mm and 0.5 kg mass. For the bending modulus of elasticity, 2200 MPa were obtained for Cajueiro and 2700 MPa for Amescla, which are considered good values. The results can be considered satisfactory because it is a preliminary and unpublished study in the case of MDP panels manufactured with Cajueiro and Amescla wood species.

Keywords Medium density particleboard (MDP), Cajueiro, Amescla, Medium density wood

1. Introduction

The wood-based panels are manufactured product with blades or particles in various stages of disintegration, agglutinated by the action of a binder (resin), heat and pressure [1-8, 14].

The wood panels were developed in the early twentieth century in America, originally from cellulose fibers - fiberboards. In the 1920s, the first hardboard pilot plant was built in Sweden, called wallboard [9].

However, only during the second world war in Germany is that was produced on a large scale panels for construction due to lack of construction materials. Only in the 1970s US start to produce panels for construction on an industrial scale [10].

The wood panels industries start to develop with a technological growing in 1980s, in agreement with a better use of natural resources like wood and also with development of better binders, new types of resins [11].

Wood panels have several applications in furnitures, construction, etc. There are several types of wood panels; one of the most common wood panels is MDP.

The material used for the production of medium density particles (MDP) is usually forest residues or waste from wood industries. The most commons woods used for production of MDP panels are Eucalyptus and Pinus. The woods Cajueiro and Amescla are typical trees from center-west from Brazil, from the States of Mato Grosso and Tocatins. These are medium density woods similar to Pinus sp, the Brazilian’s wood’s industries usually used these woods only as piece of wood for structures or furniture.

The purpose of this research is to investigate, in a preliminary study, the possibility of MDP panel’s production using Cajueiro and Amescla wood species.

2. Material and Methods

For production of MDP, the particles were produced from the residue of Amescla and Cajueiro timber through a Willye brand knife mill (Marconi model MA 680) with a sieve opening of 2.8mm to obtain the particles. It was produced 8.2kg mass of particle from Amescla and 12.2kg mass of
Cajueiro.

Later, the particles were mixed with the polyurethane resin castor oil based. Initially it was weighed around 550g of particles and added to 33 g of each resin component.

After mixing the particles with the resin, there was the pre-pressing step for forming the particles mattress in a 100Kgf load by an own manual production mechanical press of LaMEM (Wood and Timber Structures Laboratory). After the formation of particles mattress, this was taken to semi-automatic press machine (Marconi model MA 098/50), with a maximum capacity of 800 kN force and maximum temperature of 200°C.

The panels were produced under a pressure of 4 MPa for 10 minutes at 100°C, and it was produced a total of 12 MDP panels, 6 of Cajueiro and 6 of Amescla, with a thickness of 10mm, dimensions 250mm×250mm and 0.5 kg mass.

After producing the panels, the specimens were obtained for measuring the physical and mechanical properties, according the Brazilian standard ABNT 14810 [12]. Table 1 shows the dimensions and the number of specimens (NS) for each test (by panel).

| Test Initials | Width | Length | NS |
|---------------|-------|--------|----|
| Bending Static| BS 50mm | 250mm | 3 |
| Tensile Parallel| TP 50mm | 50mm | 3 |
| Pulling out screw Surface| PSS 75mm | 150mm | 1 |
| Pulling out screw Top| PST 65mm | 115mm | 1 |
| Density| D 50mm | 50mm | 3 |
| Swelling| S 25mm | 25mm | 3 |
| Absorption| A 25mm | 25mm | 3 |

From each panel it was extracted 3 specimens for the three points static bending static test, 3 specimens for density and tensile parallel to the surface, 3 specimens to swelling and water absorption, 1 specimen for pulling out screw in the surface and 1 piece for pulling out screw in the top.

The parameters obtained in the mechanical tests were the bending stiffness (MOE) and bending strength (MOR), both in MPa, these parameters were calculated by Equations 1 and 2.

\[
MOE = \frac{(F_2 - F_1) \cdot L^3}{4 \cdot b \cdot t^3 \cdot (a_2 - a_1)}
\]  
(1)

\[
MOR = \frac{3 \cdot F_{\text{max}} \cdot L}{2 \cdot b \cdot t^2}
\]  
(2)

From Equations 1 and 2, L is the distance of the panel support (mm), F2 as the load corresponding to the bending of 50% and F1 corresponding to 10% (N) of the maximum load (F_{\text{max}}), a2- a1 are the difference between the displacements at 50% and 10% of the estimated maximum load (m), b is the width (mm) and t is the thickness (mm).

For tensile test parallel to face, the calculations were made according Equation 3, where a and b are the specimens widths in both directions.

\[
TP = \frac{F_{\text{max}}}{a \cdot b}
\]  
(3)

Density of the samples was obtained using Equation 4.

\[
D = \frac{M}{V}
\]  
(4)

In Equation 4, 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 5and 6, respectively.

\[
S = \frac{E_2 - E_1}{E_1} \cdot 100 \ (\%)
\]  
(5)

\[
A = \frac{M_2 - M_1}{M_1} \cdot 100 \ (\%)
\]  
(6)

From Equations 5 and 6, E2 is the specimen thickness after water immersion; E1 is the thickness before the immersion, M2 is the mass of the specimen after water immersion and M1 is the mass before the water immersion.

All the equations are in agreement with Brazilian standard ABNT 14810 [12].

3. Results and Discussion

Tables 2 and 3 shows the values for MOE, MOR and TP for the MDP panels manufactured with Cajueiro and Amescla wood species, respectively.

Table 2. Values of MOE, MOR and TP for MDP from Cajueiro

| Cajueiro | MOE (MPa) | MOR (MPa) | TP (MPa) |
|----------|-----------|-----------|----------|
| Average  | 2274      | 18        | 10       |
| SD       | 237       | 3         | 2        |
| CV (%)   | 10        | 17        | 20       |

- SD: Standard Deviation; CV: coefficient of variation.

Table 3. Values of MOE, MOR and TP for MDP from Amescla

| Amescla | MOE (MPa) | MOR (MPa) | TP (MPa) |
|---------|-----------|-----------|----------|
| Average | 2727      | 29        | 11       |
| SD      | 608       | 6         | 4        |
| CV (%)  | 22        | 21        | 36       |

- SD: Standard Deviation; CV: coefficient of variation.

We can see different values to MOE and MOR for panels of the MDP from Amescla and Cajueiro. Typical values similar to those found by [11] around 2500 MPa (MOE). The internal bond strength values of both woods were high compared to the values found by [11] and [13], which were around 2 MPa for particulate panels.

The mechanical test of the screw pullout top and face were also performed following the Brazilian standard ABNT 14810 [12]. Tables 4 and 5 presents the results of screw pull out surface [PSS] and screw pull out top [PST].
Table 4. PSS and PST values for MDP Cajueiro

|          | PSS (N) | PST (N) |
|----------|---------|---------|
| Average  | 453     | 336     |
| SD       | 109     | 97      |
| CV (%)   | 24      | 27      |

- SD: Standard Deviation; CV: coefficient of variation.

Table 5. PSS and PST values for MDP Amescla

|          | PSS (N) | PST (N) |
|----------|---------|---------|
| Average  | 518     | 415     |
| SD       | 206     | 118     |
| CV (%)   | 40      | 28      |

- SD: Standard Deviation; CV: coefficient of variation.

Can be observed for the two types of panels a uniformity of values. However, these values were lower than those found by [11], which was 2592 N for the top screw pullout [PST] and 1417 N for screw pullout of surface [PSS].

Table 6 shows the values for density of the panels OSB manufactured with Cajueiro and Amescla wood species.

Table 6. Values of Density for MDP

|          | D (kg/m³) |
|----------|-----------|
| Cajueiro | 836       |
| Amescla  | 855       |

- SD: Standard Deviation; CV: coefficient of variation.

The values found for density for the panels MDP from Cajueiro was 836 kg/m³ and for the panels MDP from Amescla was 855 kg/m³. Similar values were demonstrated by [11], who obtained around 815 kg/m³ for the panels manufactured with Eucalyptus grandis wood specie.

Tables 7 and 8 shows the values of swelling and absorption for the panels MDP manufactured with Cajueiro and Amescla wood species, respectively.

Table 7. Swelling and Absorption for Cajueiro

|          | S-2h (%) | S-24h(5) | A-2h (%) | A-24h (%) |
|----------|----------|----------|----------|-----------|
| Average  | 9        | 18       | 14       | 43        |
| SD       | 2        | 4        | 4        | 8         |
| CV (%)   | 8.9      | 22       | 22       | 29        |

- SD: Standard Deviation; CV: coefficient of variation.

We observe that the MDP obtained values of swelling and absorption similar to that found by [11], who obtained for Eucalyptus grandis average values of 7.13%, and swelling 2h equal to 14.6%.

It is possible to relate the obtained swelling and absorption values with density. Cajueiro panel that showed the lowest density (836 kg/m³) compared with the Amescla (855 kg/m³), had higher swelling values for 2h and 24h and absorption 2h and 24h.

4. Conclusions

The production of MDP derivatives from Amescla and Cajueiro wood panels showed a good performance, but is necessary a larger study with these both woods, promoting a treatment with preservative such as chromated copper arsenate - CCA, or chromated copper borate - CCB. Observe how these preservative can affect the mechanical performance of the panels.

Increase the number of production MDP, and consequently, increase the number of specimens for physical and mechanical tests to obtain new results enabling a better statistical analysis that was presented in this research.

Although it is important to point out the potential of these medium-density woods for the production in industrial level of MDP, given that the MDP obtained (MOE) in the order of 2200 MPa for Cajueiro and 2700 MPa for Amescla, which are considered good values.

The results can be considered satisfactory because it is a preliminary and unpublished study about MDP manufactured with Cajueiro and Amescla wood species.

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