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Presenter Information

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Abstract. The present research aims to assess the physical and mechanical characteristics of gypsum-based bio-composites reinforced with *Eucalyptus urophylla* wood particles. Bio-composites with volume additions of 0%, 25%, and 50% were produced and evaluated. The results of the mechanical tests showed a statistically significant difference among the treatments, with the bio-composite with a 25% particle addition achieving a flexural strength of 2.81 Mpa and a compressive strength of 3.62 Mpa. There was a significant decrease in apparent density as the particle addition increased, with the composite with a 50% particle addition having a density of 0.71 g/cm³. All the results met normative requirements, with lower density compared to the control, demonstrating the feasibility of using the bio-composite as it fulfills the mechanical needs with less density.

Keywords: *Eucalyptus urophylla*, Sustainable building materials, wood-particles.

1 Introduction

The constant increase in the demand for global resources over the years has emphasized the importance of considering the availability of materials and sustainability in the development and use of products and services [1]. In this context, various sectors have intensified their research to find alternative resources in their production processes, driven by growing concerns about environmental issues and sustainability [2]. This quest for alternatives is crucial, as improper disposal of these waste materials can lead to significant environmental impacts, affecting both soil and surface and groundwater. A concrete example of this issue is the timber industry, which generates a substantial amount of wood waste. The inadequate utilization of these waste materials not only harms the environment but also represents a significant loss of opportunities for the industry [3].

One solution to mitigate this problem is to utilize these waste materials in the production of composite materials for use in the construction industry [4]. Given that gypsum is one of the most widely used materials in construction, incorporating waste of plant origin into gypsum-based composites represents a viable alternative to reduce environmental impacts by producing biocomposites.

The forest plantation area has been rapidly increasing worldwide, especially in the tropical and subtropical regions of South America, Southeast Asia, and Africa. Eucalyptus species and their interspecific hybrids stand out with extensive cultivated areas, primarily due to their high average productivity and adaptability to environmental conditions. One of the species with the most significant growth in planted area is Eucalyptus urophylla [5].

Thus, this work aimed to produce gypsum matrix biocomposites with the addition of Eucalyptus urophylla wood veneer waste at levels of 0, 25, and 50% by volume.

2 Methodology

2.1 Material

The composites were produced with a water/gypsum ratio of 1:1. The treatments evaluated were 0%, 25% and 50% replacement of wood particles. Discs were removed in the following portions: base, 25%, 50%, 75% and top, according to the height of the bole of each tree. The residues from the rolling and rounding of the logs passed through a hammer mill to generate ribbon-type particles, which were subjected to mechanical sieving. The particles used in the production of the composites were those that passed through the 1.83 mm sieve and were retained in the 1.69 mm sieve. Three specimens were produced for each percentage of particle addition, to evaluate density, elasticity and flexural strength in accordance with standard EN 13279-2[6]

2.2 Method

The three points of bending and compressive tests were performed in an electromechanical testing machine Arotec, with a load cell of 6kN. To each test 3 specimens were used. The tests were performed at 7 days age. The curing process after casting was after production and placed 24 hours in the oven at 40 ° C, three specimens were tested for flexion. Specimens with a dimension of 160 mm x 40 mm x 40 mm were placed in the bending test setup with a span of 100 mm. The test was performed with a rate of 50 ± 10 N/s, according to EN 13279-2[6]. After the flexural tests, the fractured specimens were sawed in cube-shaped specimens with a 40 mm side. The compression test was performed with a rate of 400 ± 200 N/s, according to EN 13279-1[7].

Apparent density was measured according adapted methodology from Brazilian standard NBR 13280 [8].

2.3 Statistic analysis

To evaluate density, compressive and flexural strength of the composites produced, the data were submitted to analysis of variance and the Scott-Knott's mean test at 5% significance. The data were statistically evaluated using the Sisvar software.

3 Results

According to Table 1, the results of both flexural and compressive strength tests exhibited statistically significant differences among the treatment groups. The composite with a 25% particle addition showed improved performance compared to the 50% addition, but still fell short of the performance achieved with the 0% treatment. The flexural strength measured at 2.81 Mpa, while the compressive strength was 3.62 Mpa. Notably, there was a significant decrease in apparent density between the control group and the treatment groups, although this trend was not observed as the particle addition increased. The composite with a 50% particle addition had a density of 0.71 g/cm³

Table 1. Average values of compressive and flexural strength and density of the composites

Tratament	Compression(Mpa)	Flexion(Mpa)	Density(g/cm³)
0%	4.23(0.05)A	3.11(0.11)A	0.94(0.02)A
25%	3.62(0.14)B	2.81(0.33)B	0.83(0.03)B
50%	2.25(0.23)C	1.89(0.19)C	0.71(0.01)C

Means followed by the same letter do not differ from each other using the Scott-knott test at 5% significance. Values in parentheses represent the standard deviation.

As a result, the addition of wood waste to the gypsum matrix leads to a decrease in density across all processed samples. This decrease can be attributed to the inherently low density of wood, with the highest density observed in the 0% addition group and the lowest density in the 50% wood particle addition group. This trend is visually depicted in Figure 1. It's worth noting that these findings are not consistent with those reported by Rivero et al. [9] and Pinto et al. [10].

This reduction in density has significant implications for the material properties and applications. In the field of composite materials, density plays a critical role in determining structural characteristics and performance. The lower density observed in these wood particle-enriched composites can contribute to reduced weight in construction and design applications, potentially resulting in lighter, more cost-effective structures [11].

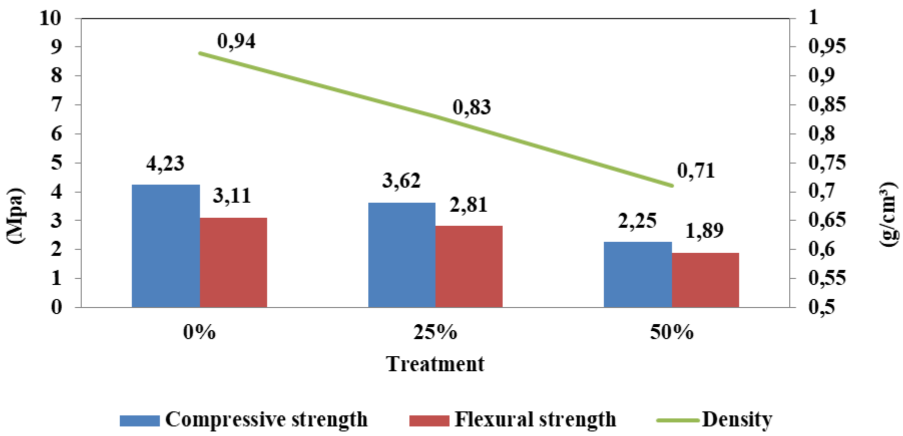

Fig. 1. Periodic drying-wetting cycles.

4 Conclusions

All the results comply with the EN 13279-2 [6], confirming the suitability of utilizing these bio composites. The mechanical requirements are met while achieving a lower density, indicating the feasibility of incorporating wood waste into gypsum composites.

In conclusion, the addition of wood waste to gypsum composites presents a promising avenue for the development of lightweight, eco-friendly building materials. Nevertheless, the observed variations in density trends compared to previous research underscore the intricacies involved in composite material development. This emphasizes the need for continuous research and refinement to unlock the full potential of these materials for a wide range of applications.

This research holds significant implications not only for advancing composite materials in construction but also for promoting sustainable practices and resource utilization. By repurposing wood processing waste and recognizing the potential advantages for the construction industry, this study makes a valuable contribution to reducing environmental impact and fostering responsible resource management in the timber sector. The results here are not only technically important but also environmentally significant, aligning with the growing global emphasis on sustainability in construction practices.

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