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SUSTAINABILITY: USE OF SUGARCANE BAGASSE AND BAMBOO LEAVES TO PRODUCE SEALING BOARDS

Camila de Brito Catosse – UNESP – São Paulo State University

Av. Eng. Luiz Edmundo Carrijo Coube, 14-01 – Bauru – SP – Brazil

E-mail: ca.milabc@yahoo.com.br - Phone: 55 (14) 31036122

Ivaldo de Domenico Valarelli – UNESP – São Paulo State University

Av. Eng. Luiz Edmundo Carrijo Coube, 14-01 – Bauru – SP – Brazil

E-mail: ivaldo@feb.unesp.br - Phone: 55 (14) 31036122

Rosane Ap. Gomes Battistelle – UNESP – São Paulo State University

Av. Eng. Luiz Edmundo Carrijo Coube, 14-01 – Bauru – SP – Brazil

E-mail: rosane@feb.unesp.br - Phone: 55 (14) 31036122

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ABSTRACT

The environmental impact caused by the uncontrolled production of solid waste has led the government and society to promote studies for alternatives that aim at minimizing the degradation of nature and increasing society's well-being as a whole, thus becoming a part of Sustainable Architecture. The purpose of this study is tied to the production of a new material, on a laboratory scale, that can be used as an option for sealing boards (ceilings and walls) in homes. Particle boards were produced using waste: sugarcane bagasse and bamboo stalk leaves at proportions of 100%, 75%, 50%, 40%, 25% and 0%, and then evaluated as to physical and mechanical characteristics. Since Brazil is the world's largest producer of sugarcane, and consequently its residue (bagasse), this study links concepts of plausible and sustainable disposal and proposes solutions to mitigate the housing deficit.

Key words: sugarcane, particle boards, sustainable architecture.

1. INTRODUCTION

The existing contradictions in urban space, resulting from capitalist production modes, are called an "Urban Issue" by Castells (2000). The high housing deficit and constant growth in the real estate market do not accompany population growth seen in the lower income population crisis. With that, the situation worsens, since this portion of the population does not count on the possibility of participating in financing plans offered by the government for they do not fit the criteria for adhesion. These problems occur around the world; however, in developing countries, like Brazil, the problem is even more developed and harder to resolve.

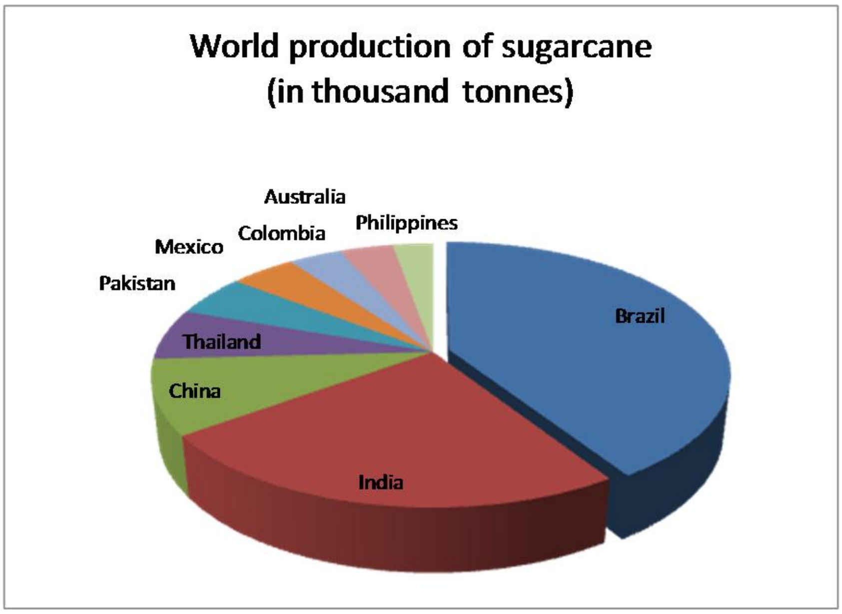
According to Engels (1873), the lack of housing is a symptom of the Industrial Revolution, with population growth estimated by geometric progression whereas the increase in food production is done by arithmetic progression – known as the Malthusian theory. The government thus responds to the lack of housing through the Malthusian moral, where researchers point out that such a crisis is due to the very poor distribution of income generated in the economy and the high value for acquiring the right to inhabit.

In face of this situation, it becomes necessary to invest in research that offers plausible solutions in order to qualify social housing as well as adjust it to large scale production. It is based on traditional principles that have worked such as self-management, house raising bees and participative budgets. Despite starting with a punctual action, and in a reduced scale (laboratory), this study seeks to mitigate the housing deficit problem by using new materials that permit lowering the cost of social housing, making it more accessible to the least privileged social class. For such, new concepts must be addressed like globalization and knowledge dissemination where the generation of solid residues, recycling and self-sustainability are the main tools for this context.

The environmental impact caused by the uncontrolled production of solid residues has led the government and society to promote studies for alternatives that aim at minimizing the degradation of nature and increasing society's well-being as a whole, thus becoming a part of Sustainable Architecture through the development of projects for new undertakings with less impact on the environment.

According to Moura (1994), in this global configuration, where the preservation of nature is inevitable, flexibility becomes a condition for survival and social progress, where yesterday's success cannot guarantee tomorrow's success. Human and society attitudes are more important than capacity. The systems are more important than the products and scientific knowledge is fundamental in relation to experience. Another consequence of similar transformation is the fact the problems are not isolated. They are all connected where we are all active and participating components.

In conformity with the problem exposed, this study seeks the development of new sustainable materials, which has become essential for recovering what has been destroyed. And geared towards Brazil's reality, sugar cane bagasse was chosen as the main raw material due to the immense planted area in the country. Although Brazil is the largest producer of sugar cane in the world – about 416,256 thousand tons (Graph 01) – sugar cane bagasse is still a little explored residue. It is still discarded in not very productive ways such as in the generation of energy for the sugar plant that processes the sugar cane, or returned to the fields as fertilizer, or simply burnt, which according to Kirchhoff (1991), results in irreparable harm to humanity, directly tied to air pollution. Thus, in a country with nearly 2,300,000 ha of sugar cane, it is necessary to develop new research and techniques that have a sustainable disposal for the residues produced by this production.



Graph 01 – World production of sugar cane-of-sugar (in thousand tonnes).

Source: the United Nations for Agriculture and Food and IBGE in Aug/2007 (www.investimentos.sp.gov.br /sis)

The second residue to be incorporated in this study is fibers found in bamboo stalk leaves of the *Dendrocalamus giganteus* species. According to Santos et al. (1998), bamboo belongs to the family Graminae, the same as sugar cane, and there are more than 1000 native species in the world, except the European continent. This monocotyledon was introduced in Brazil at the time of colonization by Japanese immigrants, and the *Dendrocalamus giganteus* species, brought here, adapted well to tropical and subtropical regions. In other words, it develops well in Brazil's edapho-climatic conditions, growing at an accelerated rate since reproduction is asexual and replanting is not necessary.

Species this study focuses on, called *Dendrocalamus giganteus,* has been grown since 1994 at the Unesp Mechanical Engineering Department's Experimental Agriculture Area / Bauru Campus, SP, and is part of the Bamboo Project being developed by the University. In this experimental area, measuring approximately 1 ha, there are 25 thickets of the species under study, resulting in an estimated total of 10,000 leaves per year, or about 500 kg of leaves that are discarded and not used.

The purpose of this study is thus tied to the search for new sustainable materials that can be used in the future as an option for sealing panels in social housing. Together with the performance (good), low cost (practically zero) and use of these boards, if they are employed, we can project good market acceptance while also contributing towards a reduction in the Brazilian housing deficit, and most importantly, offering a better destination for sugar cane residue (bagasse) and bamboo stalk leaves.

These boards are similar to those made of wood for the compensated and agglomerated furniture market. In 2002, there was record production in Brazil, with more than 6.283 million m^3 of compensated boards. In Brazil, this production increased significantly in 1996/2002; 44% over the five years. This increase continued in 2002/2003, according to

FAO (2005), at around 20.7%. Global production of agglomerates reached 84 million m³. Brazil is ranked ninth, with 2% of the produced volume (FORTES, 2005).

However, much is commented in the scientific community about the chaos the wood sector is in, where huge areas of our native forests are part of the past and the crisis worsens not only the disappearance of fauna and flora, but also the political and financial issue of our country, which encompasses an entire sector of workers.

According to Fade (2008), there are technological advances that seek to expand the supply of raw materials, such as the exploration of exotic forests rather than native ones, bringing the market a large supply of Pinus and Eucalyptus species, which today dominate the wood production chain in Brazil.

In face of these facts, researchers of material technology around the world, including Cuba, Colombia, China, Argentina and Russia, are increasingly more engaged in the production of new composites based on vegetal fibers as an alternative to traditional wood panels. Many studies successfully used the same principle as this one (BATTISTELLE – 2002 and 2004, WIEDMAN – 2002, IWAKIRI et al. – 2000, VALARELLI et al. – 2006 and 2008), applying solid residues to manufacture particle boards to be applied later in diverse sectors, whether industrial or in civil construction.

2. OBJECTIVES

The general objective of this study is to show the technical feasibility of manufacturing, in laboratory, of particle panels using *Saccharum hibridas* sugar cane bagasse, derived from processing the sugar cane, and *Dendrocalamus giganteus* bamboo stalk leaves, as inputs, since these residues are disposed of improperly due to a lack of information and knowledge in the waste recycling and reuse area. Besides that, the objective is to demonstrate that these residue boards have physical and mechanical properties that are similar to commonly sold panels (agglomerated wood panels).

3. MATERIAL AND METHODS

In order to develop this study, the residues were collected and the inputs duly treated. The boards were manufacture with different proportions – 100%, 75%, 50%, 40%, 25% and 0% – of shredded bamboo leaves in relation to the total mass of composites, completed with properly treated sugar cane bagasse. The boards were distinguished using standardized assays that evaluated the coefficient of water absorption, moisture content and specific mass, and they were then assessed as to resistance to static flexion and resistance to traction parallel to the fibers. All of the assays followed the procedures shown in Nascimento (2003) and ABNT norm – 2002 and NBR 14810.

The manufacturing of boards and the running of assays took place in the Residues Laboratory and the Construction Materials Laboratory at the São Paulo State University, Department of Civil Engineering, Bauru campus. The following materials were selected to make the boards used in this study:

- Sugar cane bagasse;
- Bamboo stalk leaf fibers;
- Cascamite PB-7082 urea-formaldehyde resin (UF);
- Paraffin emulsion;
- Ammonia sulfate;
- Water.

4. RESULTS

The first procedure was to collect the sugar cane bagasse from distillers in the central region of Bauru, SP, who had acquired this material from fields in the city of Pederneiras, SP. The material was collected after being ground in strips. The bagasse was treated, dried natural and artificially (in the sun and kilns, respectively), and then shredded, sieved and weighed.

The bamboo stalk leaves were removed from the Unesp Department of Mechanical Engineering Experimental Agriculture Area / Bauru Campus, SP. The residue separates from thicket stalks spontaneously in mid-March. Soon after gathered, they are manually broken into small samples and later shredded and ground, sieved and weighed.

Figure 01 – General view of the various sheets of particles ready.

After the correct preparation and weighing of residues, the adhesive was prepared with a mixture of water (5% of adhesive), ammonia sulfate (1.5% of adhesive) and paraffin emulsion, (1.5% of total mass of particles), which was then incorporated to the mass of residue particles.

The UF adhesive chosen for the production of boards for this study is called Cascamite PB-7082, manufactured by Alfa Química, Ltda. According to Olmos (1992), this adhesive is classified as synthetic in origin and water resistant, and it also has good resistance to moisture. It has a low cost compared to other adhesives, a light color and permits combination with vegetal extenders to further reduce cost.

The paraffin emulsion is commonly used as an additive in adhesives used in the wood particle board production. Its function is to fill in any possible spaces between particles inside the board. The manufactured composite will thus reduce its water absorption capacity.

The ammonia sulfate used in this study is from Bandeirantes Química LTDA located in São Paulo. It acts like a resin curing agent for wood boards.

After preparing the adhesive and adding it to the residues, a mattress is formed that is take to a hydraulic press at a temperature of 110° C, shaping the boards. These were cooled vertically and cut in squares (Figure 1).

Finally, with the proper test bodies, the physical assays could be performed (specific mass, moisture content, absorption and swelling), obtaining the following results:

Table 01: Average results obtained in physical tests.

PROPORTION	MASS (g/cm^3)	MOISTURE (%)	ABSORPTION (%)		SWELLING (%)	
			2h	24h	2h	24h
Proportion 1	0.741	10.73	54.54	80.33	18.81	25.29
Proportion 2	0.742	11.08	28.27	61.36	6.45	12.25
Proportion 3	0.747	11.84	19.63	51.05	2.99	9.76
Proportion 4	0.737	11.16	19.25	56.59	3.98	11.29
Proportion 5	0.759	10.88	18.59	54.02	4.2	13.34
Proportion 6	0.690	9.75	24.93	86.51	9.13	25.85

5. CONCLUSIONS

Sugar cane bagasse, the largest residue from Brazilian agroindustry, and the fibers from *Dendrocalamus giganteus* bamboo stalk leaves, a natural resource that takes the least time to be renewed and is found in the most part in Brazilian agriculture properties, have the potential to be used in the manufacturing of particle boards adding value to residues with their application in sealing boards.

The boards produced meet esthetic expectations with very uniform characteristics and an appropriate texture to be used in the housing market for walls and ceilings, without any need for paint or wallpaper, and thus of easy acceptance by the consumer market.

It is possible to produce homogeneous particle boards (HPB) in laboratory with average values and variability of properties equivalent to boards manufactured on an industrial scale with densities varying from 0.9 to 1.0 g/cm^3.

The assays show that:

- specific mass was practically constant at 0.75 g/cm^3, which NBR 14810-2 classifies as average density, except for proportion 6, which obtained an inferior value, 0.69 g/cm^3;
- the moisture content also remained with constant values at around 11%, which are within NBR 14810-2 parameters, which indicates between 5 and 11%. Only proportion 6 (100% bamboo leaves) had a lower value (U=9.75%), but still within the norm;
- in the absorption assay, proportion 3 had the lowest value (51.05%), which also occurred in the swelling assay (9.76%), and the proportions with higher values for both assays were proportions 1 and 6.

It is important to underscore that in this first evaluation of the boards, the need to redo proportions 1 and 6 for the next phase of the study was confirmed since they both presented values that were not projected. We point out that this study aims at evaluating the boards in physical assays (already conducted) as well as mechanical assays, which will be concluded by the date of the event’s exhibit.

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