STUDY OF THE POTENTIAL USE OF THE SUGARCANE BAGASSE IN CEMENT-PANELS

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Summary: This study aimed the potential application of sugarcane bagasse fibers “Saccharum officinarum L.”, by-product lignocellulosic from agri-businesses in Brazil, in the fabrication of cement panels. The potential was evaluated by a thermometry method. This analysis consisted in the monitoring of the first 24 hours curing temperature of the cement (Portland) mixed with fibers. A sample of cement without the fibers was used as control. In this study, the fibers were cut to 8 mm length and treated at hot water (at 100°C during 60 min). Cellulose, hemicellulose, lignin and extractives soluble in water of the fibers were analysed. The potential results showed satisfactory results when comparing the literature. The inhibition rate obtained from sugarcane fibers was 6%. The maximum temperature was 56°C. While the control maximum temperature obtained was 85°C. This difference suggests that fiber of sugarcane bagasse can potentially be used in cement panels
1 INTRODUCTION

The construction system’s optimization are increasing due to the need to reduce costs and waste minimization. The panels based on lignocellulosic material were insert into the class of products that help the industrialization of construction. These panels apply to walls, floors, roof modular manner, and the ease of use.

The panels with cement and lignocellulosic materials can be produced of lignocellulosic material particles bonded by mineral adhesive, water and chemical additives, consolidated by cold pressing [1].

This type of cement panels, for example, is used in the construction sector in Austria since 1920 and in Germany since 1940, and had it is expansion after World War II to Australia, the US and Asia. Large-scale production began in 1976 in Germany, and expanded to the United States (wood fiber cement) and Mexico (cement-bonded particleboard). The acceptance are linked to the use of inorganic binder, which gives the superior properties than synthetic resin plates, ensuring resistance to fire, fungi, termites attack, thermal and acoustic insulation [2].

The production of these panels is relatively small, when compared to conventional particleboard production. The small capacity occurs due to the slow cure process of the panels. Cement and lignocellulosic materials panel’s production is similar to that used for conventional panels, being differentiated by the type of binder inserted and particles [3].

These particles are aggregated to empowering agents where the cement is the binder; the reagent is water and chemical additives that reduce the setting time of the cement [1].

The bigger difficult to production these panels are the high weight, the slow cure and particularly the selection of suitable species for production. Several studies have shown that the healing ability of cement in the presence of lignocellulosic material is determined by the chemical composition thereof and cement does not react equally well with all kinds of materials [4].

The sugarcane bagasse is the fibrous by-product generated by the process production of alcohol and sugar, after extraction of sugarcane stem juice. This by-product has great value as an energy source used as fuel. Between 2013/2014, the production of cane sugar in Brazil was around 658,822 t, grown in an area of approximately 8.893mil ha. Among the producing states, São Paulo is responsible for 51.43% of total production of the country [5].

The nature sugarcane bagasse is composed approximately by 44.5% of lignocellulosic fibers, 50% moisture, 2.5% soluble solids in water and 3% ash content [6].

Taking into account the high volume of solid waste produced and the environmental factor, the development of alternative materials with the application of different waste may present a possible use of these and so avoid the inappropriate disposal.

Among the possibilities in question, some are linked to the construction, highlighting studies [7]; [8]; [9].

However, the addition of these materials can result in some problems, for example, high density of the final product and the inhibitory effect on lignocellulosic material caused by the cure process of the cement, mainly polysaccharides and extractives, which may affect reactions with the cement, resulting low quality panels [10].

Studies conducted to evaluate the impact of the botanical components of the sugar cane bagasse fibers in cement handle process. These authors concluded that the water-soluble sugars, hemicellulose and lignin are responsible for the delayed and reduced the maximum cement hydration temperature. An alternative to this problem may pretreatment of lignocellulosic material or washing the fibers in water (boiling water or cold). In order to remove impurities and residual reducing sugar, treatment consist in boiling water immersion
of the fiber in boiling water (100°C) for 30 minutes followed by washing in water and drying in air for over 48 hours at 24 60°C oven. According to the authors treat the pre-wash the sugarcane bagasse significantly decreased the residual sugar content.

Some tests suggest assessing the compatibility of wood with cement. However, one of the most applied consists in measuring the elevation of temperature during the hydration process of the cement. The use of compatibility testing between wood and cement, using temperature of cement hydration as a benchmark, is perhaps the ideal test in which must precede the stage of produce of the panels. This test is very important because the type of treatment and chemical additive particles used may be previously set, without first having to make the panels.

Based on the concept of thermometry, this study aimed to evaluate this technique for the potential application of the sugar cane bagasse fibers treated for use in cement panels.

2 MATERIALS AND METHODS

This study used Portland cement CP V-ARI PLUS (high early strength), NBR 5733 (ABNT, 1991). His choice was due to their high initial resistance, which helps reduce the handling time of precast and is the same used in the panel industry and the research carried out by several authors. [4]; [11]; [2]; [13].

Sugarcane bagasse used in this study was collected in an industry of sugar cane bagasse process located in the state of Sao Paulo-Brazil.

Prior to receiving any processing, was dried at 60 ° C, and was then sieved to remove the thinner portion. The particle was obtained by milling knife mill with a mesh of 8 mm. After these processes the fibers with 8mm was treated.

This treatment consisted in the immersion of the fiber in boiling water (100°C) for 30 minutes followed by washing in water and drying in air for over 48 hours at 24 60°C oven.

Chemical tests were conducted to quantify the content of cellulose, hemicellulose and lignin and extractives soluble in cold water (23°C) and hot (100°C).

The chemical tests to determine the cellulose, hemicellulose and lignin from lignocellulosic materials used Methodology described by the French Association of Normalization [14]. The solubility in water, cold and hot, was determined according to the standard established in standard American Society for Testing and Materials [15].

The inhibition rates were calculated according to equation 1 [16]. The equation besides hydration time, also incorporates the maximum temperature of the lignocellulosic material cement mixture and water-cement, and the maximum rate of time and temperature.

\[
I = \left\{ \left[ \frac{T_{cem} - T_{lm}}{T_{cem}} \right] \times \left[ \frac{H_{lm} - H_{cem}}{T_{cem}} \right] \times \left[ \frac{S_{cem} - S_{lm}}{S_{cem}} \right] \times 100 \right\}
\]

Where:
I= Inhibition rates (%);
T_{cem}= Maximum temperature cement;
T_{lm}= Maximum temperature cement more lignocellulosic material;
H_{cem}= Time to maximum temperature cement;
H_{lm}=Time to maximum temperature cement more lignocellulosic material;
Matheus Roberto Cabral, Juliano Fiorelli, Holmer Savastano Junior, Robert Lagacé, Stéphane Godbout, Joahnn H. Palacios

Scem= Maximum increase of cement;
Slm= Maximum increase of cement more lignocellulosic material.

To the lignocellulosic material cement compatibility was used the classification system used by table 1 [1].

<table>
<thead>
<tr>
<th>Inhibition ratio (%)</th>
<th>Classification</th>
<th>Inhibition ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 until 10</td>
<td>Low</td>
<td>1 until 10</td>
</tr>
<tr>
<td>10 until 50</td>
<td>Intermediate</td>
<td>10 until 50</td>
</tr>
<tr>
<td>50 until 100</td>
<td>High</td>
<td>50 until 100</td>
</tr>
<tr>
<td>More than 100</td>
<td>Very high</td>
<td>More than 100</td>
</tr>
</tbody>
</table>

Table 1 Inhibition rates

The cement amounts and the lignocellulosic materials particles were weighed (200 g and 15 g), respectively, thus keeping up a lignocellulosic material-cement ratio 1:13. To calculate the required water was used to Equation 2 [17].

\[ \text{Water (g)} = \text{Water rates: Cement} \times (g) \left[ \text{LM (g)} \left(0.3 - \frac{\text{HD (100%)}}{100}\right) \right] \]  \hspace{1cm} (2)

Where:
LM=Lignocellulosic material
HD = humidity of dry lignocellulosic material.

The particles, cement and water were mixed in a beaker, in which the total elapsed time for mixing these components did not exceed five minutes (figure 10), and immediately transferred to a plastic bag (19,7 x 28,6cm). Then, the wire thermocouple was inserted into the mixture, which was closed. The set, with the cable connected, was placed inside the vacuum flasks and the closed. Each experiment consisted of three replicates.

The temperature measurement thermocouples type "J" were used. These thermocouples were attached to a manufacturing data acquisition system Campbell Scientific Data 21X, in which the data was generated and stored. Each cable was connected at one sample with minute intervals over a total time of 24 hours. Subsequently, data were transferred to a microcomputer and processed by means of Microsoft Excel.

A was adapted system to place the cement-lignocellulosic material water with the thermocouple cable and a system with four 500 ml bottles thermal capacity inside the insulated box, fully insulated with glass wool.

3 RESULTS AND DISCUSSIONS

The table 3 show the chemical results to the lignocellulosic materials. The cellulose, hemicellulose, lignin content and the extractives
The results obtained for values cellulose, hemicellulose, lignin and lignin material were similar to those found in the literature.

Extractives are composed of substances such as tannins, gums, dyes, starches, fats, resins and phytosterols and others, which may be removed with cold or hot water, or organic solvents, commotion ethanol, toluene, acetone or dichloromethane. These extractives determine characteristics such as color, design, smell, natural strength to chemical attack of the lignocellulosic material [18].

Such extractives are related to the cement hydration process, in order to assess possible future treatments for lignocellulosic materials were performed analyses of extractives soluble in cold water 23°C and hot water 100°C to determine the extractives of lignocellulosic material. (Table 3).

<table>
<thead>
<tr>
<th>Analysis of soluble extractives of sugarcane bagasse fibers (%)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Cold water (23°C)</td>
<td>7,1</td>
</tr>
<tr>
<td>Hot water (100°C)</td>
<td>7,7</td>
</tr>
</tbody>
</table>

Table 3 Extractives results

Studies of extractives soluble in cold and hot water and are best realized. For example, studied extractives soluble in hot and cold water 13 tropical species. Explained due to its low glucose concentration 1-2% are better to produce cement materials without interfere on the setting time of cement [2].

The evaluation the results to the potential or inhibition rates were based according methodology [1]. Based on aptitude test results, it can be seen the degree of inhibition of lignocellulosic material with cement used, and thus the quality of the forward panel produced with this material. The values obtained in the aptitude test shown in Table 4

<table>
<thead>
<tr>
<th>Inhibition rates (%)</th>
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<tbody>
<tr>
<td>Fibers of sugarcane</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 4 Inhibition rates results

The inhibition rate obtained from sugarcane fibers was 6%. The maximum temperature was 56°C. While the control maximum temperature obtained was 85°C. The results were above eucalyptus bark [19]. This difference suggests that sugarcane bagasse fibers can potentially be used in cement panels.
4 CONCLUSIONS

The inhibition rate obtained from sugarcane fibers was 6%. The maximum temperature was 56°C. While the control maximum temperature obtained was 85°C. This difference suggests that sugarcane bagasse fibers showed potential to use in cement panels.

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