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Preparation of Fiber-Reinforced Composite using Sugarcane Bagasse Fiber: A Possible Substitute of Plywood Used for Furniture Making

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ABSTRACT

This paper introduces the design and analysis of the mechanical properties of composite textile compounds (bagasse fiber). Fiber-reinforced compounds (FRC) are known for their strength and lightweight structures that make them suitable for many industrial applications. Sugar is called sugar in Pakistan, and it is widely available after processing and extracting sugarcane juice. The sugar waste in useful products has great potential for many uses. In this study, Bagasse fiber has been used in a single fiber form combined with epoxy for additives. The base of the fabric made of this material can replace plywood and leather board. Furniture is usually made of wood or wood veneer, such as plywood or parquet. The development of integrated production technology helps to find the best binding location between the fiber and the matrix. The shape of the bagasse fiber indicates excellent flexibility or elasticity, and the same plywood samples of the same size and length are tested. This study looks at sugarcane bagasse fibres reinforced with epoxy resin for composite materials, which have higher bending strength and flexibility than plywood. The findings indicate that bagasse-based composites are a sustainable, high-performance, and cost-effective option for industrial applications.

1. Introduction

Composite is manufactured by combining two essentials. A compound is produced by combining two essential ingredients to obtain better properties of the resulting product than its resulting properties [1]. Nowadays the health and environmental factors are always kept in mind; the production of raw materials has environmental and technological potential. The basic composition of decaying fibers containing natural fibers is essential for the production of immature mixtures. [2].

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Ingredients reinforced with natural fiber are used more slowly due to their deterioration, low density, low cost, and natural environment [3].

A high number of sugarcane residues exist after a very dangerous sugar extraction process. Crop residues included wheat husks, rice husks, hemp fibers, and many dried fruit husks [4]. Recent research has focused on the development of cellulosic fibers. These include crop modification/removal technology and integrated production. Many research projects have been reported to make natural fiber computers more economically viable and to increase their capacity [5].

Over the past decade, much emphasis has been placed on environmental awareness and the development of new ecosystems [6] . Therefore, research work involving a class of natural fibers, such as raw silk, banana fiber, raw juice, wood, fertilizer, pineapple leaves, and even bamboo fiber, the field of the building is now a new way for researchers in the sciences and engineering has attracted attention [7]. The use of these fibers with naturally occurring polymers and biological resources promotes new categories of building materials and goods in many few developed countries where environmental awareness is very important [8]. There are many advantages and disadvantages of raw chemicals that contain natural fibers over a class of regular synthetic fiber like glass; For example, keeping somewhat, high durability, low density, strength value is good, and biological degradation to use composite materials [9].On the other hand, the weak localization between natural fibers and polymer composites is an important concern that should be pointed out in the mentioned, to improve the quality, characterization, and properties of raw materials [10]. Fiber mixing, also a form of the Matrix Edition, is an integral part of polymer-reinforced fiber composite systems to improve composite structure and performance [11]. Given the concept about the background, research of the work and development of materials related to biomass is an important topic. In particular, natural plant fibers, such as saffron, ramie, banana and hemp, and other synthetic fibers are worth seeing [12].

In bagasse fiber, the most important component present in the structure is called cellulose. It's one of the greater presences in the fiber as it reviewed the structure of the components [13]. The part of the polymer which belongs to the organic phase with the number of units is 2000 to 3000 monomers in polymer chains. It has a gravitational force of about 1.55. However, cellulose is very crystalline. Bagasse fiber is 10-34 (μm) in diameter, and 0.8-2.8 (mm) in length [14]. As noticeable in the formation of plant fibers, the main component is cellulose following the attached structure of hemicellulose and lignin units. The main cellulose unit acts as a stabilizer for lignin, hemicellulose, and pectin. Bagasse fiber is natural, and its chemical composition is shown in Table. 1. The flexible strength of celiac fiber fabric (bagasse) may reach different loads and pressures on conventional plywood as a product [15]. These composite structures promote the market and performance of raw materials in front of plywood furniture [15]. This gap in knowledge underscores the need for comprehensive studies that can optimize the properties of bagasse composites and demonstrate their viability as alternatives to plywood.

A basic experimental study has pointed out some facts related to bagasse fibers to be used as potential furniture. Agriculture in Pakistan is a major occupation and bagasse residues can be incorporated as commercially to make solid fabric polymer compounds.

2. Research Methodology

The study, Cellulosic bagasse fiber has used and a reinforcing substrate for the fabrication of composite, further materials, and equipment's are listed below:

- Dry Oven
- Digital Balance and Microscope
- Poly-functional resin (Ethylene Oxide)
- Polyamine Hardener
- Cobalt
- Mold

To analyze and find the green composites' different properties results, the SHIMADZU UH-500KNI Universal Testing Machine model 2012 has been used with the load cell of 500 KN.

After the preparation of green composite and comprehensive adjustment, various properties such as strength, and flexibility were tested and evaluated.

2.1 Baggase Fiber

The Bagasse fiber cellulosic based (sugar waste) has been a residue found after extracting it in the form of liquid from the steam of sugarcane. After the alcohol was released from the sugar industry, the fiber was dried at 80 ºC for 72 hours. The bagasse fiber is then cut and sorted according to size. The composition based on chemical components of the fiber differentiate from place to place, type, and method of washing and collection. Table 1 has mentioned the chemical composition of cellulosic-based bagasse fiber[16].

Table 1
Composition residue of Bagasse fiber

Component	Percentage
Cellulose	45-55 %
Hemicellulose	20- 25 %
Lignin	18-24 %
Ash	1-4%
Waxes	<1 %

As shown in Figure 1, the bagasse fibers were carefully examined under a microscope

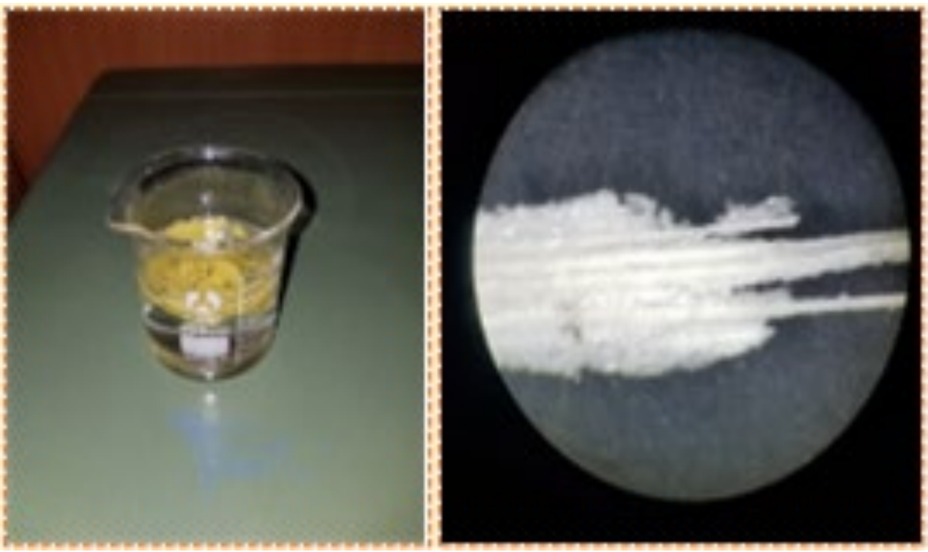

Fig. 1. Microscopic view of bagasse fibres (left), Washing with NaOH (Right)

As shown and mentioned in Figure 2, the 30 cm long bagasse stems are fed with a set of rolls, from which the juice is extracted and separated from the broken stems. The rollers which belong to the inner side are fitted with the blades, while the outsider rollers have been lightened to direct the piece to the station [17]. The extracted peat protrudes through the roof, is fed to the conveyor, and in the commercial process, a piece of rind moves in the succeeding station, which eliminates the outer layer of wax. To remove fibers from the band, 1 standard sodium hydroxide (NaOH) solution was applied at 120ºC.

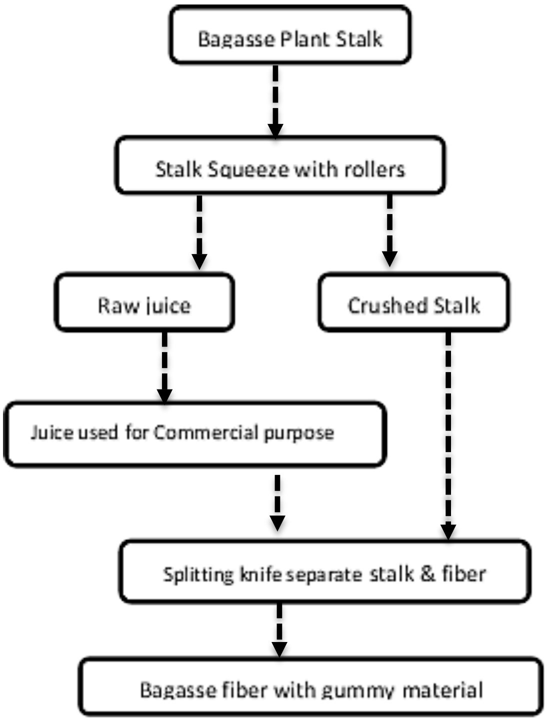

Fig. 2. Extraction flow chart for Bagasse fiber from steam

2.2 Resin of Poly functional Amines & Hardener

In general, epoxy resin has chemical resistance, strength, and durability. They have high performance at high temperatures, up to 121ºC temperature/water temperature. Poly point's resins become liquid, hard, and slightly soluble [18]. They can be treated with amine or acid anhydride reactions.

Polycoated epoxy resins cannot withstand catalysts, such as polyester resins. A therapeutic agent called a hardener can be used. Both the hardener base and the resin participate in the combined response such as "additional reaction", depending on the set value [19].

Therefore, to ensure and satisfy a reaction that has been completed, it is compulsory to apply the exact amount of resin mixture to the concrete. To acquire the finest resin composite properties, it should be treated properly[20]. To prepare our packaging, we used ethylene oxide, a natural compound with the formula C_2H_4O.

2.3 Mold

In the process of molding, molding is molded. Inside the mold, the reinforcing elements and the matrix are diversified and pressed. However, the way of treatment and parameters, temperature, and time must be adjusted just to follow the polymer substrate and the matrix [21]. The formulation function has a therapeutic response, which is replaced by the provision of additional heat or regenerative chemicals (such as organic peroxides). In many techniques whereas molding introduces, it is especially appropriate to refer to them as the "lower" mold and the "upper" part of the mold.

2.4 Composite Technology

Bagasse-resin compounds are made as follows. That mold has been cured at 160° C for a time of 15 minutes. The temperature has reached the 158-162° C building substrate and is being pressed and stored at 10 MPa for 10 minutes. Epoxy resin besides hardener and cobalt which bought the commercial market are used. Combined, the bagasse fibers are evenly circulated to accomplish the same results. Finally, the prepared substrate is baked in a dry oven at 120 ºC for 10 minutes.

2.5 Integrated Layout Repairs

To make epoxy resin, measure the next mixture and place it in a glass oven. The therapeutic agent can be measured and coated with epoxy resin. The Cobalt is already combined with epoxy resin and hardeners. Then mix with the solution. Below are detailed descriptions of the weight of each item used in the compilation.

Weight of resin = 280 gm
Weight of Cellulosic fiber = 28 gm
Hardener weight = 7gm
Cobalt with weight = 5gm
Bagasse fiber ratio: Resin, 1:10

3. Results & Discussion

Before assembly, the extracted samples have been carefully observed with a view of a laboratory microscope, as represented in Figure 1. As the weight inclined is positive from 0 to 6 N, the wire shows strong pressure. Whereas the load reaches 19.5 N, the fiber shows high resistance. After that, they tend to shrink and gradually return to normal (Figure 4).

Fig. 3. Strict power test setting on bagasse fibers

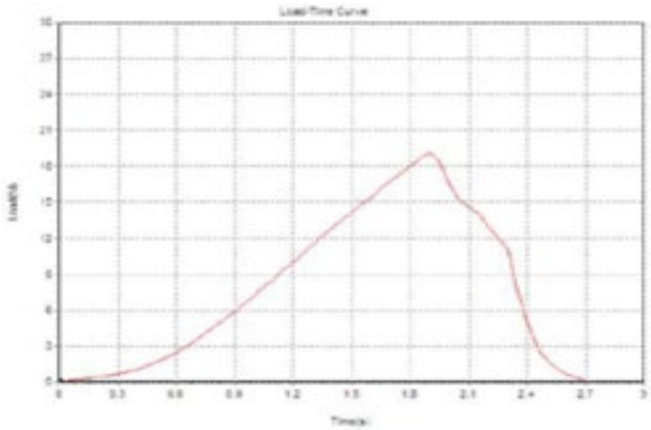

Fig. 4. Strength of bagasse fiber

After fixing the compound with bagasse fiber, a flexible test was performed using a three-point bending method by ISO 178 (Figure 5). Five examples of each composite material are provided. The sample size was 30 X 15 in length and width with a thickness of 1.8–1.9 mm. For safety from temperature effects, every useful examination test has been applied at 26 ° C. As shown in the figure, the span length and cross-section velocity are 18 mm and 1 mm / min, respectively. The line curve removal was analyzed to determine the total number of dynamic models and total sample power.

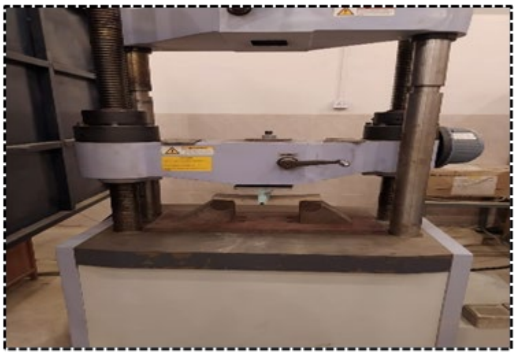

Fig. 5. Flexural strength Testing setup

After examining the both bagasse fiber sample and the plywood samples, the results have been revealed in Figure 6 and 7. The result has been revealed that the maximum strength of a bagasse fiber compound of about 390 N is found at about 9.64%. In plywood models, the maximum strength is obtained at about 375 N in about 7.3% of the type***.***

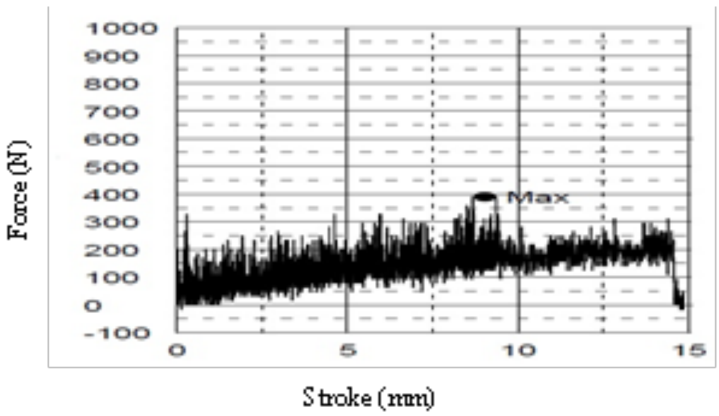

Fig. 6. Strength of bagasse composite

more efficient and sustainable ecosystems has increased. Natural fibers consisting of both natural fibers are compounds and destructive compounds. The composites in this work are made of solid bagasse fiber and composite epoxy resin made with mold technology. Bagasse is also a widely available fiber recycled and recycled in Pakistan. Environmental pollution can be reduced with the help of recycling bagasse fiber. A combination of green bagasse matrix can be used instead of plywood furniture. Plywood materials are also very expensive and require a lot of energy to prepare them. The combination of green bagasse shows the strength of fine bricks against a plywood sample of the same size and length. The raw combination of sugarcane waste (raw bagasse) and epoxy resin proves a decent strength compared to the plywood substrate used in the furniture industry.

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