RESEARCH ARTICLE

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# Influence of Filler Material on Natural Fiber and its Properties

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## ABSTRACT

Natural fibers are materials directly extracted from plants, animals, and minerals. Because of its many advantages, natural fibers utilization and the importance of these materials were increased. Among all fibers, hemp fiber is one of the strongest and stiffest plant-based fibers in the cannabis species family. Most researchers are still working on materials in various ways to improve these properties. We were worked out in a further extension of the previous paper to study some other properties of hemp fiber by adding the red brick powder at different weight percentages into it.

Similarly, after the sieve analysis, a fine powder form was produced from red brick, added to the epoxy material. By applying the hand layup method, fiber-reinforced polymer composites were manufactured. Charpy, hardness, and water absorption tests were performed on these composite materials, and a comparison was made along with pure hemp fiber. Among all, 40% of the sample received the highest value in hardness, while in Charpy, pure hemp was recorded. Similarly, a slight impact on weights in the water absorption test was recorded.

**Keywords:** Charpy, Hardness, Sieve analysis, Water absorption.

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## INTRODUCTION

In the present scenario, most of the research work is carried on composite materials preparation, and these materials are primarily preferred in various conditions. Among all lightweight, ease of availability and cost are a few; with this aspect, these composite materials were also being fabricated with one of the lightweight materials called fibers. Natural fibers are one of the fibers extracted from the plants; to improve the strength of these composites, powder form of materials was introduced during the fabrication process. In this paper, the importance of the Hemp fiber and the utilization of fine brick powder at different weight percentages during manufacturing defined its properties and shown in Figure 1 & 2 [1]. Most researchers are working on it by adding the various organic and inorganic powder forms of materials as a part of it; alumina filled jute fiber mat was fabricated and studied its impact on water absorption and impact strength properties. It defines that while increasing the filler content in jute epoxy composite, the diffusion coefficient decreases and increase in impact strength observed up to 10wt% of alumina filled specimen [2]. Similarly, the red mud filler material particle size process and its weight percentage impact on properties were also analyzed by adding hybrid composites [3]. Adding Doum palm shell particles into the polymer materials improved the energy absorption, dissipation, and flexibility [4]. Rice husk was treated with chemicals at different media, and a comparison was made

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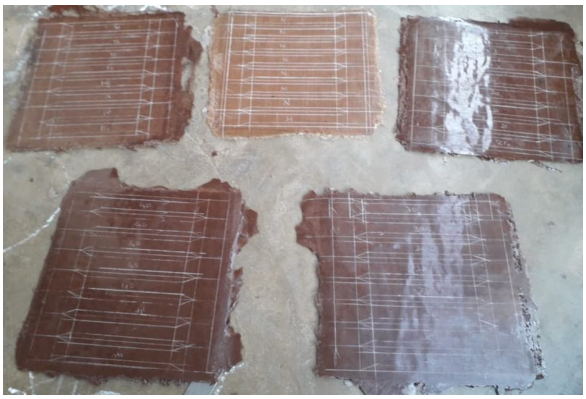
among them with untreated reinforced composites [5]. While in the case of calotropis procera, the increase of fiber loading parallelly increases the water absorption capacity [6]. Not only fiber loading but the length of the fibers has also created an impact on mechanical properties [7]. In the cotton fabric reinforced geopolymer composites, water absorption capacity was increased due to fiber content [8]. Then as well as in the case of bamboo fiber/powder composites, tensile and flexural properties were increased by increasing the fiber content [9]. Hybridization of banana and glass fibers, with filler materials at different percentages composites, were prepared and studied its properties [10]. A study was made on mechanical properties variation by changing the mesh number and the ratio of materials. Finally, it's been concluded that up to a specific size of mesh number, the properties of composites made by wood powder and starch were being increased, and later a decrease in properties was observed [11]. In this paper on a sisal and bagasse fiber composite hybrid, its mechanical and water absorption properties were studied [12]. A shell powder-filled glass fiber composite was used to perform a wear test on it, among which good vibrational characteristics were recorded at 5% sea shell-filled composite laminate [13]. Using tea and iron powders during the manufacturing of composites their impact on the properties of materials was being analyzed [14-15]. While in this paper it defines that a proper staking sequence of hybrid fibers may result in lightweight and fewer cost applications in the automobile industry [16]. Among the various assessed fibers for mechanical properties, it concludes that ukam and sisal composites are suitable for high-performance polymer composites [17]. Simulation of tensile, compression and, bending were performed on sisal fiber, sugar cane powder mixed hybrid composites [18]. A moringa oleifera pods fiber was used to study its mechanical and tribological properties, among which treated polymer composites receive better properties than the untreated MOPF polymer composites [19]. Filler material loading may increase properties up to particular conditions but decreases due to the weak interfacial bonding [20]. This review paper reported various natural, hybrid, and nanocomposite's dynamic mechanical properties, which helps to analyze its industrial applications [21]. By considering the polyalthia longifolia seed powder as a filler material under different weight ratios, composites were manufactured and studied their physical, chemical, thermal, and mechanical properties; apart from this, its characterization techniques were also studied [22]. Optimum results of sisal-fiber-reinforced with homopolymer polypropylene composites were recorded under a KOH chemical treatment process [23]. In addition, composites were fabricated by varying the rice husk powder and coir fiber with a constant resin and studying their tensile, flexural, and impact properties. Among which tensile property was increased due to increased coir percentage, flexural was increased due to increase of rice husk powder. In impact strength, an equal portion of coir and rice husk composite has an improvement [24].

## MATERIALS AND MANUFACTURING

Hemp fiber in a mat form was selected as the primary material for composite manufacturing. A wax and plastic film was used during the fabrication process, LY556 and HY951 were used as epoxy and hardener in a ratio of 1:10. The mat form of hemp fiber was chosen to manufacture a composite material by an adequately known hand layup method. Initially, a thin film with wax was taken and placed a proper size of fiber mat on it. Then epoxy and hardener were mixed thoroughly without having an air bubble in them. Then, a powder form of red brick material with a sieve size of 75microns was added and mixed thoroughly. This powder form of material was added at different weight percentages, and layer by layer, the paste form material was applied to the fiber mat. This process was repeated until the desired thickness of composite laminate was received. Figure 1 & 2 shows the manufacturing process as well as prepared samples of composites.

(a)

(b)



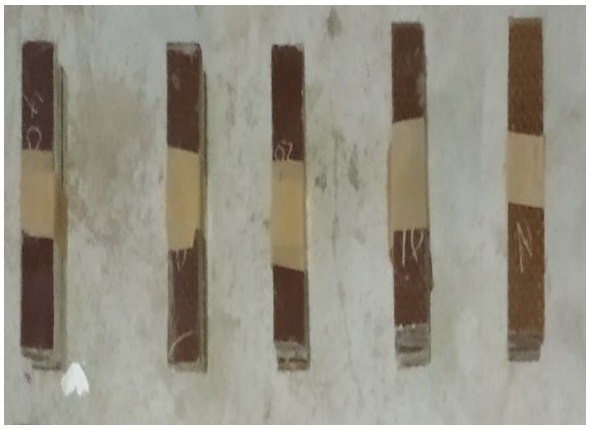
(c)

(d)

**Figure 1:** (a-d) shows the various stages of fabrication process (a) Pure Hemp fiber mat (b) Applying the brick powder mixed epoxy resin on fiber (c) Fabricated samples of 0%, 10%, 20%, 30%, 40% compositions (d) Samples cutting process.

## MATERIAL TESTING

(a)



(b)

**Figure 2:** a, b shows the hardness, water absorption, and Charpy test specimens.

### Rockwell Hardness Test

This test was performed on the prepared samples using a 1/16" ball indentor at a load of 60kg values taken during the 10s of dwell time. From each composition, a single specimen was used for the experiment, and three indentations were marked on it; average values were taken from them. The below table 1. shows the hardness value of each component of the specimen; from figure 3. it is observed that 40% of brick powder treated hemp fiber records the highest value than the remaining compositions of composites.

**Table-1:** Shows the values of the hardness test

| S. No | 0% | 10% | 20% | 30% | 40% |
|---|---|---|---|---|---|
| 1 | 91 | 95 | 89 | 87 | 101 |
| 2 | 89 | 85 | 87 | 83 | 91 |
| 3 | 81 | 89 | 80 | 87 | 98 |
| Avg. Value | 87 | 89.67 | 85.33 | 85.67 | 96.67 |

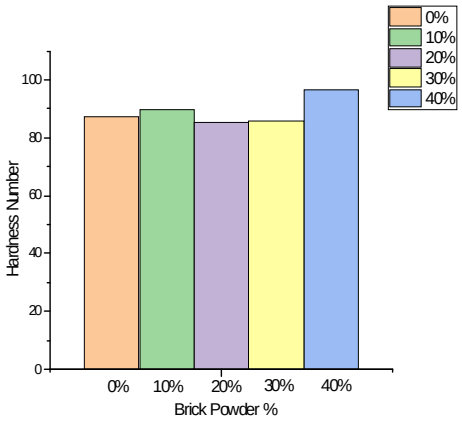



**Figure 3:** Represents the hardness value of different composites

## Charpy Test

According to ASTM standards, three samples from each composition were prepared and performed the Charpy impact test. The Charpy test is similar to the Izod test. It is also a pendulum-type test, but in this test, the specimen is clamped sideways by securing it at each end. The sample could have a V-shaped or U-shaped notch, and the notch faces away from the pendulum. The test device itself could be a benchtop size or a larger, floor-size model. Figure 4 shows the recorded values of different percentages of polymer composites, among all the 0%, i.e., pure hemp fiber composite has the highest value than the remaining composite materials.

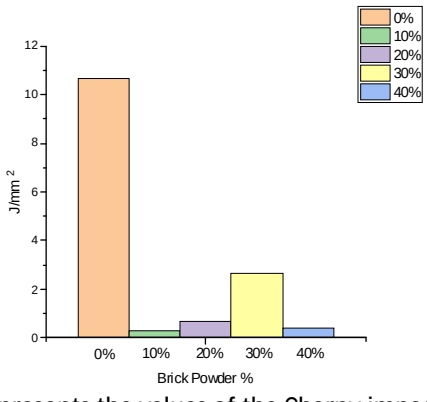



**Figure 4:** represents the values of the Charpy impact test

## Water absorption test

This test was performed by dissolving the specimens into distilled water, and these were prepared according to ASTM standards. Initial weights of the samples were noted with the help of a 0.001 accuracy weigh balance machine. Then three samples were taken from each component of the polymer composites and mentioned its values in Table 2 and presented in figure 5.

**Table-2:** Represents the initials values of the specimens

| S. No | 0% | 10% | 20% | 30% | 40% |
|---|---|---|---|---|---|
| 1 | 5.686 | 5.78 | 4.842 | 4.572 | 4.628 |
| 2 | 5.732 | 5.425 | 4.968 | 4.609 | 4.655 |
| 3 | 5.205 | 5.513 | 4.868 | 4.426 | 4.697 |
| Avg. Value | 5.673 | 5.407 | 4.963 | 4.381 | 4.659 |

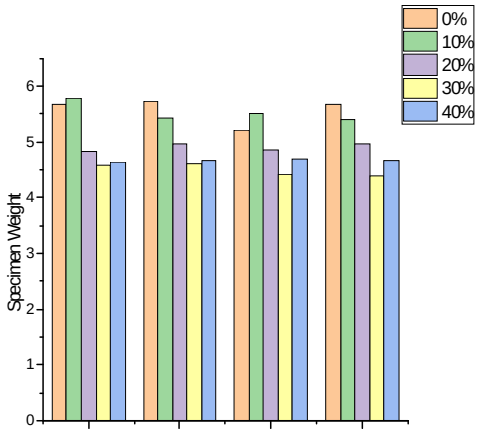



**Figure 5:** represents the initial weights of the samples

Similarly, the weights of the samples taken from the distilled water at different time intervals were also noted and mentioned in table 3.

**Table-3:** Shows the values of specimens at different periods

| Time Period | 0% | 10% | 20% | 30% | 40% |
|---|---|---|---|---|---|
| 12hrs | 5.718 | 5.806 | 4.875 | 4.605 | 4.66 |
| 60hrs | 5.797 | 5.485 | 5.037 | 4.675 | 4.718 |
| 84hrs | 5.422 | 5.588 | 4.944 | 4.506 | 4.76 |
| 108hrs | 5.618 | 5.495 | 5.088 | 4.473 | 4.794 |

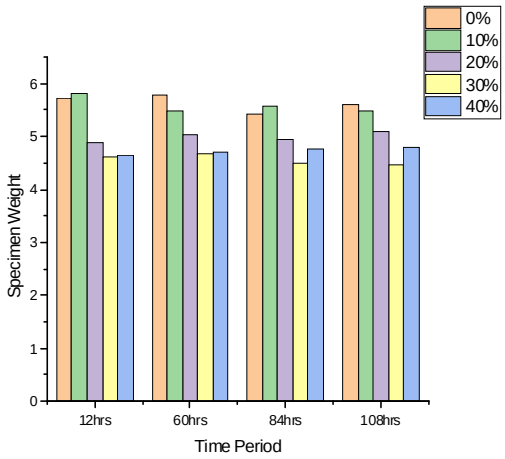



**Figure 6:** Represents the weight of the samples at different time intervals.

The above figure 6 represents that the weight of each composition's sample gradually increased or decreased during different periods, and the same observation was recorded in the case of 20% brick powder composition. During the period of 108hrs improvement in a sample, the weight has occurred. Among them, gradual improvement in specimen weight even by changing the period was recorded at 40% composition, and similarly at 30% composition records the lowest water absorption capacity than the remaining.

## CONCLUSION

As an extension of a previous paper, we have fabricated the samples of composites again according to the ASTM standards for studying the different properties by performing Charpy, hardness, and water absorption tests on them. after that, the above results the following conclusions were made.

- After performing the hardness test on these specimens, a gradual increase and decrease in the different compositions of composites were observed up to 30%. The highest value was being recorded at 40% among all.
- While in the Charpy test, pure hemp fiber, i.e., 0% of brick powder composite material, has a maximum value than the remaining composites, which defines that hemp fiber has a suitable property of impact load.
- In the water absorption test, there was a slight impact of brick powder on the initial and final weights of the different compositions of polymer composites. Even the same was observed in different periods.

Finally, we state that the impact of brick powder was observed in hardness property, while a slight variation was reported in Charpy and water absorption tests.

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