Experimental Analysis on Water Absorption Behaviour of Natural Composite Materials

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Abstract. This research work deals the fabrication process of naturally available composite fibers with appropriate proportions. Though Natural fiber based composite materials are occupying the suitable position in the Aircraft Manufacturing process. Compositions of cellulose and lignin in the fibers are the low influencing alternative for the other form of composites and that comes under the category of Natural Fibre Composites. In order to strengthen the Natural Composite Materials the fibre reinforced composite materials are basically reduce the percentage of volume comparatively to the natural Composites very high volume fraction especially to provide strength and stiffness. To enhance the materials quality of Natural Composite Materials the water absorption as well as the tensile analysis has been experimented with the combinations of coir and hemp natural composite. The surface treatment process said to be Alkaline was applied to the combinations of coir and hemp. Hand layup method has been used to fabricate the expected laminates with proper thickness and dimensions. Finally the fabricated samples were subjected to water absorption test through which the mechanical property has been observed. During this process coir and hemp were proportionally mixed in the ratio of 0:100, 100:0, 25:75, 50:50 and 75:25. During the heat treatment process, the simplest equipment Hot Air oven has been used for maintain the desired temperature to dry the samples.

Keywords: Natural Composites, Coir, Hemp, Water Absorption

1. Introduction
Animals and Plants are the major sources for making natural composite fibres. These sources are readily available as the renewable one. Recent days the Automobile and Aerospace Industries have been effectively utilizing the composite materials for making the structural components. According to the materials manufacturing process, numbers of industries are being involved in producing different formats of structural components for variety of applications. Considering the factor of safety and light weight, Aluminum is always one of the best for making Aerospace related structural parts. Recent days the uses of composite materials are increased among the Aerospace Industries. Because of their low density as well as the very good thermal insulating properties, the Natural composite Materials are low weight and high strength to carry more loads. So that the Aerospace Industries are developing their structural components with Natural Fibre based materials especially aims to cost reduction purposes. It has been observed that the combinations of Hemp and Coir compositions are good enough to withstand more mechanical strength. Coir is a kind of coconut based natural fiber which is taken out from the outer layer of the coconut husk. The coir fibers are always more resistance to water, corrosion resistance property is more unless it is processed with sea
water. Most Probably the Fresh water is used for making the Coir in brown colour, then the mixer of sea water and fresh water are used for making the coir in white colour. While the Hemp is predominantly used for producing the daily life products such as textiles, shoes, paper, bio fuel, plastics and insulating materials.

With respect to the phenomenon such as biodegradable, recyclable and sustainable, the hemp based fiber materials has been captured the market with attractive profits. And the usages also increased among the public in recent years. Some Plant which has stem and are used for making Hemp with very high strength and stiffness which is essential requirements for the reinforced composite materials. However the mechanical and structural properties are in variability for Hemp based natural composite materials.

If the Hemp composite materials are mixed with materials such as thermoset and thermoplastics, then then it can gain more or good mechanical properties with efficient structural stability. There are many surface treatment process were applied to the Hemp fiber matrix to make the internal structure of hemp with very strong bonding medium. It has been observed that the basic physical properties of coir consists of 30% of breaking elongation with the diameter of 0.1 to 1.5 mm as well as the Modules of rigidity about 1.8924 dyne/cm² and are swelling the water with the diameter of 5%.

The basic treatment commonly called as Alkaline Process a kind of chemical treatment has been generally applied to the natural fibres. During this treatment process, the Sodium Hydroxide (NaOH) in a concentrated form might be used approximately at given temperature over the period of time. Naturally the Cellulose materials has the effective component of stiffness. So that the Alkaline processed Natural fibers exhibits very high mechanical properties and improves the stiffness of matrix components. Sometimes Alkaline process has been applied prior to water absorption test for special case of Natural fibers such as hemp and coir.

2. Experimental Details

During the preliminary investigation process, it has been decided to choose coir and hemp as the reinforcement materials in order to make the smooth fabrication of laminates. The company called Covai Seenu, Pvt Ltd supplied the special hardener HY951 and Epoxy resin (LY556) to make the perfect laminates. Also the high quality natural composites such as Coir and Hemp were taken from the Sathyamangalam Tiger Reserve Forest. The mixing ratio of resin and hardener were given to 20:1. While 20 ml of epoxy resin and 1 ml of Hardener for mixing the selected natural composites. The test specimens are prepared as per the ATSM D570 standards.

3. Chemical Treatment

According to the investigations, the chemically treated natural fiber composite materials were utilized for further industrial applications. While conducting the chemical treatment process, the Hemp and coir were mixed with proper proportions so that the expected level of laminates may encounter the effective mechanical properties. But the Major disadvantage is the poor compatibility between natural fiber elements and matrix element which are low rate of moisture absorption properties. In order to make the effective mechanical surface properties of natural fibers, Alkaline based chemical treatments were performed with experimental set-up.

3.1. Hand Layup Method

One of the low cost investment based composite manufacturing method has used in this paper to produce coir-hemp laminated sections. Here it has been produced with Hand layup method for the fabrication of Natural composites. During the beginning of Fabrication process, the fibers are prepared a woven type, and are physically inserted in the midland also the special brush has been used in order to apply the resin matrix on the reinforcing matrix component.

Thereafter the Hand roller has been utilized for rolling process to wet the proportion of composites and also ensured the uniformity of natural fiber elements as well as resins are in the expected level of thickness with proper distributions. Then the final product of laminates has been subjected to curing process with Hot Air Oven at the temperature of 90 Degree Celsius for 120 Minutes. Overall this experimental process were divide into as such as Preparation of Molding, Applying the gel coat, Hand layup and Curing action. Hand layup method has been effectively used for making marine and aerospace components based on the natural fiber reinforcement process.
4. Water Absorption Test

After the chemical treatment process, the Fabricated Natural fiber based composites were taken out and immersed in the water setup basically at room temperature. It has been shown that the more water observed then the chances for increasing the mechanical property.

For the betterment of calculating the level of water observed the laminates, the weight difference between the dry and wet samples were found out with digital meter and also the values are taken for the further process.
Due to the chemical structural arrangements of laminated composite materials, micro molecules are attracted by the water elements that creates the strong polymer chain bonding structure. The water absorption test were conducted for the estimated time periods. 30min, 60 Min, 120 Min, 240 min and 600 min.

5. Result And Discussion

The combination of coir and hemp shown their natural characteristics in which the combinations are test with different intervals and are projected in the following Table 5.2.A.

| Time  | H:C(100:0) | H:C(0:100) | H:C (50:50) | H:C(25:75) | H:C (75:25) |
|-------|------------|------------|-------------|------------|-------------|
| 10    | .265       | .652       | .589        | .698       | .364        |
| 30    | .479       | .85        | .796        | .895       | .558        |
| 90    | .898       | 1.23       | .982        | 1.23       | .789        |
| 120   | 1.63       | 1.96       | 1.256       | 1.56       | 1.64        |
| 24    | 1.098      | 2.25       | 1.36        | 1.89       | 1.54        |
| 360   | 1          | 2          | 1.28        | 2.04       | 1           |
| 600   | 1.054      | 1.78       | 1.08        | 1.16       | 1.34        |

It has been observed from the experimental data, as time increases the water absorptions of the laminates were also increased. The laminates are fabricated as per the proportions mention in the table 5.2.A.

![WATER ABSORPTION OF COMPOSITE AFTER ALKALINE](image)

Figure 4: Graphical Representation of Water Absorption Natural Fiber: Hemp and Coir

The filler element Basalt could be added during the surface treatment process according to the dimensions of the laminates structure so that the resultant mechanical behaviors have been enhanced to the maximum levels. The improved water absorption properties are observed as 69.7%, 75.1%, 77.3%, 98.5% and 85.8% respectively for the combinations such as C:H (0:100, 100:0, 50:50, 25:75, 75:25)
6. Conclusion
It has been observed that the Coir and Hemp based Natural fibers are practically very low cost based materials and the fabrication method used here does not emits CO₂. According to the water absorption characteristics of Natural Composites such Coir and Hemp combinations are good enough to observe the water molecules. Overall the fabrication process gives the smooth surface based Coir-Hemp laminates that can be used for making the different components. It has been observed from the mechanical test, the tensile load carrying capacity of wet samples are greater than the Dry laminates. Finally it was concluded that the water absorption test supports the natural composites to increase the mechanical properties. The water intake properties results in the experimentation that exactly improved the qualities of Hemp – Coir combinations of Natural fibers. The hybrid composite 25% Coir and 75% of Hemp have more water absorption properties than the remaining proportions of Coir and Hemp. The percentage of water impact characteristics varies from 69.7% to 98.5% and it is sufficient for making durable mechanical structures. Hence it has observed that the expected fabricated laminates are very close to the experimental results though effectively used for different applications. Improvement of water absorption was more for Hemp and Coir based materials with high mechanical strength compared to the carbon and banana based natural fibers.

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