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Investigation on the Water Absorption Behaviour and Machinability of Areca Shell Fiber and Areca Palm Powder Reinforced Natural Composites

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Abstract: *This article describes the study of moisture absorption behavior and machinability of Areca shell fiber, Areca palm powder and Epoxy reinforced natural composites. The results showed that, the moisture absorption of untreated composite is more compared to the treated composites. From the Machinability test it is identified that surface roundness of untreated and treated areca shell fiber and areca palm powder composites at high drill speed shown better result and less damage factor than Commercial Teakwood.*

Keywords: *Water absorption, Machinability, Areca shell fiber, Areca palm powder.*

1. INTRODUCTION

The unique and diverse characteristics of composite materials have caused an increase in their utilization worldwide. A composite is a structural material which consists of combining two or more constituents. The constituents are combined at a macroscopic level and are not soluble in each other. One constituent is called the reinforcing phase and the one in which it is embedded is called the matrix [1].

A vast amount of research in polymer matrix composites has been done either by trying to combine new elements or improving existing polymer matrix composites with chemical treatment or by establishing better manufacturing route. Since the cost of the elements such as metals is expensive and non-renewable, some of the focus of polymer matrix composites turned to the application of natural fibers; fibers from plants especially as reinforcing matrix.

The tensile test, moisture absorption test, and biodegradable tests on areca fiber composite laminates with randomly distributed fibers in maize stalk fine fiber and phenol formaldehyde conducted by Mohan kumar G C [2]. He prepared Composite laminates with different proportions of phenol formaldehyde and fibers. For the all above tests he observed that alkali treated fibers produced good results. Water Absorption behaviour of Areca Fiber Reinforced Polymer Composites was studied by Srinivasa. C.V et. al.,[3]. In his research he used fibers from the areca husk and chemically treated. He prepared composites using urea-formaldehyde resin with randomly orientated of fibers. Based on the criteria that fibers are the main load-bearing agents, the composites were prepared with 60% of areca fibers and 40% of the matrix. The specimens were immersed in seawater, river water, pond water and ground water at room temperature. He observed that Areca composites showed more absorption of pond water compared to bore-well water and seawater.

In this work studied the effect of chemically treated and untreated behavior of moisture absorption and machinability of Areca shell fiber, Areca palm powder and Epoxy reinforced natural composites.

2. EXPERIMENTAL DETAILS

2.1. Material Selection

Matrix Materials

Epoxy resin is widely used in industrial application because of their high strength and mechanical adhesiveness characteristic. It is also good solvent and has good chemical resistance over a wide range of temperature. The purpose of using this Epoxy as a resin is that, it is having a medium viscosity, non-crystallizing epoxy material, with room temperature curing properties. Lapox L–12 and hardener K–6 is used in the present investigation. The purpose of using hardener is it acts as curing agent. The weight percentage of hardener used in the present investigation is in the ratio of 10:1.

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Reinforcement

Reinforcements can be both natural and man-made. In this work Areca shell fiber is used as reinforcement material and betel palm powder used as a filler material.

Fig 1: *Areca shell fiber*

Fig 2: *Betel palm powder*

2.2. Specimen Preparation

Specimens of different sizes required for different tests according to ASTM standards were made ready. The test specimen along with their dimensions and standards for different tests are discussed below.

Moisture Absorption Test Specimens

Moisture absorption test specimens were prepared according to ASTM D5229 standard. The photographic view of specimen is shown in Fig. 3. The specimen used is a rectangular bar of 45mm length, 25mm width and 6mm thickness.

Machinability Test Specimens

Machinability test specimens were prepared. The photographic view of specimen is shown in Fig. 4. The specimen used is a rectangular bar of 45mm length, 25mm width and 6mm thickness.

Fig 3: *Moisture Absorption Test Specimens*

Fig 4: *Machinability Test Specimens*

2.3. Experimentation

The specimen immersed in water to conduct the moisture absorption test is as shown in Fig. 5.

Fig 5: *Set-up for Moisture Absorption Test*

The specimen positioned in the Profile Projector for Machinability test is shown in Fig. 6.

Fig 6: *Set-up for Machinability Test*

3. RESULTS AND DISCUSSION

Analysis of the machinability and moisture absorption of composites are the most important aspects. Performance testing of mechanical behavior and moisture absorption of composites depend on the nature of matrix material, the distribution and orientation of the reinforcing fibers, the nature of the fiber-matrix interfaces. Even small changes in the physical nature of the reinforcement for a given matrix may result in prominent changes in the overall machinability and moisture absorption of composites.

3.1. Moisture Absorption Test

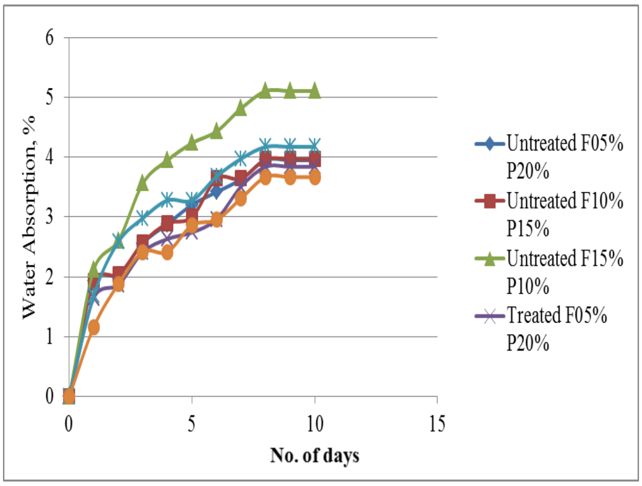

Fig 7: *Comparison of moisture absorption behaviour of untreated and treated Areca shell fiber in normal water*

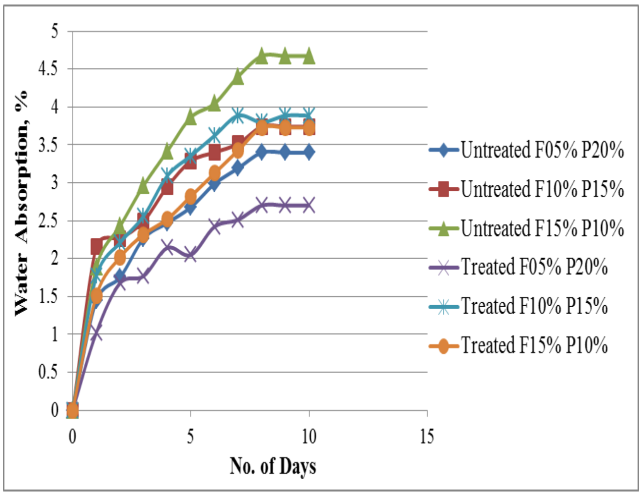

Fig 8: *Comparison of moisture absorption behaviour of untreated and treated Areca shell fiber in borewell water*

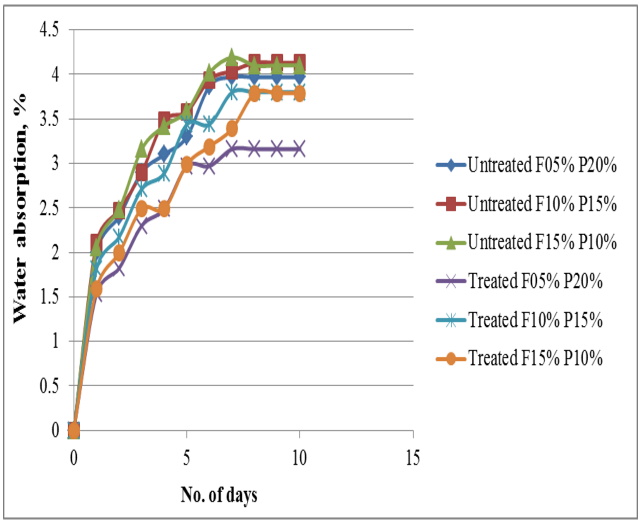

Fig 9: *Comparison of moisture absorption behaviour of untreated and treated Areca shell fiber in distilled water*

Figs. 7, 8 and 9 shows moisture absorption test results for normal water, borewell water and distilled water respectively. From the plotted graphs it can be observed that the amount of moisture in the composite increases with time and later levelled off at longer period, which is an indication of saturation. Lignocellulosics change dimensions with changing moisture content because the cell wall polymers contain hydroxyl and other oxygen containing groups that attract moisture through hydrogen bonding. The hemicelluloses are mainly responsible for moisture absorption, but the accessible cellulose, non-crystalline cellulose, lignin and surface of crystalline cellulose also play major roles [4]. Moisture swells the cell wall, and the fiber expands until the cell wall is saturated with water (fiber saturation point). Beyond this saturation point, moisture exists as free water in the void structure and does not contribute further expansion.

The composite specimens absorb moisture about 10 – 14 % of their weight. Compared to conventional wood based particleboard the percentage of absorption is very small. Whereas the moisture absorption for wood based particleboard is more than 40%. Therefore this experiment shows that the composites made of Areca shell fiber and Betel Palm powder have very less percentage of water absorption.

Furthermore, the figures also show that the treated Areca shell fiber and untreated betel Palm powder reinforced composites absorb less water compared to untreated fibre and powder reinforced composites. This may be due to the change in the surface topography of the fibers due to chemical treatment. The chemical treatment of the natural fiber removes lignin and hemicelluloses from the surface. The chemical treatments had removed most of the hemicelluloses and lignin and thus Areca shell fiber become more hydrophobic and the composites with treated fiber absorb less water [4] and [5].

Table 1: *Percentage of moisture absorption*

Untreated Composite Specimens			
Specimen code	Percentage of Moisture absorption with		
	Normal Water	Bore Water	Distilled Water
F05% P20%	3.948%	3.398%	3.97%
F10% P15%	3.961%	3.741%	4.13%
F15% P10%	5.101%	4.672%	4.10%
Treated Composite Specimens			
F05% P20%	3.837%	2.700%	3.16%
F10% P15%	4.170%	3.886%	3.80%
F15% P10%	3.667%	3.729%	3.79%

The percentage of moisture absorption with different water sources shown in the table above is assumed to be due to the variation in the pH values and ionic changes of the water.

3.2. Machinability Test

Surface Roundness Test results of Untreated and Treated Composites with Teek Wood at Low and High drill speed as follows.

Table 2: *Comparison of the surface roundness of Untreated and treated composites with Teek wood at low and high drill speed*

Specimen Code	Drill Speed in RPM	Time taken to drill in Seconds	Surface Roundness on x and y axis		Damage Factor
			X, mm	Y, mm	
For Low drill speed					
Wood	600	6	4.951	4.685	1.072
Untreated F05% P20%	600	9	5.075	4.765	1.062
Untreated F10% P15%	600	8	4.925	4.95	1.025
Untreated F15% P10%	600	9	5.025	5.010	1.007
Treated F05% P20%	600	8	5.205	4.89	1.063
Treated F10% P15%	600	8	5.155	4.780	1.075
Treated F15% P10%	600	9	4.975	5.040	1.013
For High drill speed					
Wood	2700	3	5.01	4.99	1.004
Untreated F05% P20%	2700	5	5.095	4.985	1.022
Untreated F10% P15%	2700	4	5.03	4.970	1.012
Untreated F15% P10%	2700	4	5	4.98	1.004
Treated F05% P20%	2700	5	5.055	4.985	1.014
Treated F10% P15%	2700	4	4.955	4.89	1.031
Treated F15% P10%	2700	4	5.005	4.910	1.019

In the above results we observed that the damage factor of high speed drilled hole is less compare to the low speed drilled hole in case of Fiber composite as well as Wood also. This may because of proper speed is not given to the particular volume fraction of composites to produce a good hole.

From the above result we conclude that Areca Fiber Composites which might be recommended for high speed machining operations because of its less damage factor [6].

4. CONCLUSION

Some conclusions can be drawn from the results of experiments as follows.

- The untreated composites exhibit 10% higher water absorption resistance compared to treated composites.
- In the results of Machinability test the surface roundness under the influence of high speed drill operation is good and it has less damage factor than the holes of low speed drilling operation.

REFERENCES

[1] Krishan K. Chawla, "Composite Materials", Third Edition, 2011.

[2] Mohan Kumar G C, "A Study of Short Areca Fiber Reinforced PF Composites", Vol II, WCE 2008, July 2008, pp. 3-7.

[3] Srinivasa C V and Bharath K N, " Water Absorption behaviour of Areca Fiber Reinforced Polymer Composites", International Journal of Materials and Biomaterials Applications, 2(2), 2012, pp. 12-14.

[4] Dhanalakshmi, Sampath kumar, Ramadevi Punyamurthy, Srinivasa Venkateshappa C, and Basavaraju Bennehalli., "Effect of Chemical Treatment on Water Absorption of Areca Fiber", Journal of Applied Sciences Research, 8(11), 2012, pp. 5298-5305.

[5] Mwaikambo L Y and Ansell M P., "The Effect of Chemical Treatment on the Properties of Hemp, Sisal, Jute and Kapok Fibres for Composite Reinforcement" 2nd International Wood and Natural Composites Symposium, June 28-29, 1999 in Kassel.

[6] Naveen P N E, Yasaswi M and Prasad R V" Experimental Investigation of Drilling Parameters on Composite Materials", IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE), ISSN : 2278-1684, Volume 2, Issue 3 (Sep-Oct. 2012), PP. 30-37.