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# Mechanical Properties of Treated Single Areca Fibre

Prajesh Yogeshbhai Ashra[1], Santosh Kumar[1], Shyamili c[1], Sachin Kumar[1] and G B Vaggar[2]
[1]Student, Alva's Institute of Engineering and Technology, Moodbidri - 574 225, Karnataka, India.
[2]Faculty, Alva's Institute of Engineering and Technology, Moodbidri - 574 225, Karnataka, India.

***Abstract-*** *Natural fibre (NF) composites are gaining importance by the researchers and scientists because of their advantages over synthetic fibre composites. The drawback of using any NF as the reinforcement in the composite formation is its hydrophilic nature because of its high cellulose content. This will weaken the strength of the composite prepared from the NF. To overcome this problem, various chemical treatments can be done, so that it modifies the surface properties of the fibres and makes it hydrophobic which thereby increases the mechanical properties of the composites. The surface modification of areca fibre was done by treating with NaOH at different concentrations and exposure time. The fibres were then subjected to the mechanical characterization. It showed that the mechanical properties of the treated fibres increased to an appreciable extent in comparison with untreated fibres. Thus the areca fibre serves to be a promising material in composite manufacture.*

**Keyword: Areca fibres, NaOH, Concentrations, Exposure Time.**

## I. INTRODUCTION

Composite is defined as combination of two or more chemically or physically distinct material with the use of adhesive or binder giving rise to a component achieving the properties which a single material cannot achieve. The composites are consider two have two components namely matrix and reinforcement where the reinforcement gives superior mechanical properties and the matrix acts like binder that distributes load and also gives toughness. The composite can be classified based on two types based on reinforcement, based on matrix. They are usually classified based on matrix namely metal matrix composite, ceramic matrix composite, polymer matrix composite

The rising development in the field composites has given rise to the production of different types of composites. To overcome the environmental hazards caused by using of the metal and synthetic fibre composite, tremendous development in the field of Natural hybrid composite is done. Natural hybrid composite is defined as the composite made by using natural fibre generally one fibre is organic other is inorganic as the fibre used are natural they are biodegradable they do not cause any environmental hazards. The fibre generally used to produce a natural hybrid composite are jute, kenaf, banana, sisal, flax, hemp, coir, cotton, areca, etc.

Areca belongs to family palmecea to the species areca catechu Linnaeus originated in Malaya peninsula, East India. Areca trees are used for production of nuts, fibres and oil. About 60-80% total weight and volume of areca fruits consists of hard fibrous material. The fibres diameter generally range between 0.285-0.89mm, the average length of single fibre varies between 29-38mm and gives a good density of 1.05-1.25 g/cm$^{3.}$ the chemical composition of areca fibre consist of 35-64.8% of hemicellulose, 13-24.8% of lignin and 4.4% of ash the hemicellulose content of areca fibre much greater than any other fibres. The main disadvantage of natural fibre reinforced composite is that it absorb moisture content from the environment which creates a deformation on the surface due to swelling of the composite and void creation. Hence, the natural fibre is proved to have very low strength when compared to synthetic fibre reinforced composite. The deformation not only leads to lower strength but also increase in the weight of the composite. As the moisture content changes the lignocellulosic changes the dimensions because the cell wall contain hydroxyl and other oxygen containing groups. Which attracts moisture through hydrogen bonding. The hemicellulose is the reason for moisture absorption, moisture swells the cell wall and expands the fibre until it is saturated with water. After the saturation point moisture exists as free water in the void structure and does not contribute in any further expansion. The hydroporocity which is created is the main challenge for both the composite fabrication and the performance of the end product. Natural fibres tend to absorb lower moisture in the end product of the composites as they are partially covered with the matrix. However even little moisture absorbed can highly affect the performance of the composite.

The areca fibre are abundantly available in nature. The nut shell is rigid and fibrous material. The tensile strength of the areca fibre is higher than that of many other natural fibres such as coconut, kenaf, palm fibre, etc.

The properties of the areca fibre are generally not constant they depend on many other factor such as surface treatment, extraction process of the fibres and manufacturing process. Hence it is very important to select a proper optimized process in order to achieve suitable end product depend upon the application of the composites [26]

## II. MATERIALS AND METHODOLOGY

### a. MATERIALS

The fibre used in this particular experiment is areca fibre and a brief comparison is made between the mechanical properties and changes in the stress and strain of the treated as well as the untreated areca fibre. The fibre are treated by dipping it in different concentration of NaOH viz. 1% NaOH , 2% NaOH,3% NaOH ,4% NaOH and 5% NaOH for different time interval viz. 24hrs, 48hrs, 72hrs, 96hrs.

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b. FIBRE EXTRACTION

The areca fibre are extracted from the empty shell of areca fruit in dry condition the shells are dipped in deionized water for 5 days this procedure is called as a retting. The retting is done in order to empty the fruit effectively making it easy for fibre extraction by loosening the fibre. The fibre strands are extracted effectively from the fruit shell using comb. The impurities are present such as broken strands are removed using sieve. The strands of areca fibre stored at a temperature of 30˚C and 70% relative humidity this processes is carried for a period of 72hrs before the strands are send for chemical treatment

c. CHEMICAL TREATMENT OF AN ARECA FIBRE

Areca fibre were immersed into stainless steel containers containing 1%, 2%, 3%, 4%, 5% NaOH at room temperature for time interval of 24hr, 48hr, 72hrs, and 96hrs for each concentration of NaOH the treated fibre are then immersed into the distilled water for 24hrs to wash off the residual of NaOH from the strands the strands are again washed in distilled water containing 2% acetic acids finally to remove the last trace of acid on the fibre it is washed in running water. The pH value of the fibres is calculated to be approximately 7 then they are placed in hot air oven at 70˚C for about 3hrs obtaining dehydrated alkaline treated areca fibres. The dehydrated treated alkaline fibres are the stored in air tight containers according to the concentration of NaOH and time interval respectively. The air tight storage containers are used in order to avoid any further moisture absorption.

Fig. no.1: Treated Areca Fibre

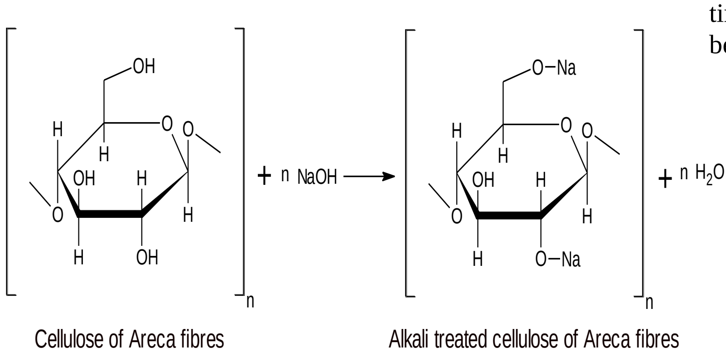


Fig.no.2: Reaction between untreated areca fibre and sodium hydroxide

The cellulose fibre swells up as result of being treated in the alkaline solution. The change in the hydrogen bonding of the fibre enhances the mechanical properties of the fibre. The treated fibre is proved to be rough which helps the fibre to bond with the matrix which helps in improving the mechanical properties of the composite to be formed.

d. TENSILE TEST

First the tensile test was carried out on untreated Extracted fibres. The Mecmesin MultiTest-Xt Machine is used for testing the tensile test of the fibre the machine consist of 3 load cells 100N, 500N and 2500N. For the testing of single fibre the load cell used is 100N. The software used for compiling the data of the test and obtaining the graph is Emperor ™. The machine is equipped with a hydraulic unit. The display unit gives the output of the tensile test in form of a graph.

For the testing 20 samples from each concentration and time interval are taken respectively and clamped in the UTM for the tensile test. The machine is programed in advanced to set the maximum amount of load to be applied and the maximum distance to be travelled by the clamps. The diameter of the fibre were measured using optical microscope at first and the results obtained from the optical microscope were then compared with the result obtained from the Digital Vernier caliper the difference found in the reading was negligible so the rest of the measurements were carried out using the digital Vernier caliper. For a single strand three to four diameter reading were measured throughout the length of the strand and then the average of all the diameter was calculated for 20 samples for each individual concentration and time interval. The average of the diameter of each samples was calculated and fed in the software to calculate area of the fibre. Finally the test was carried out on the, test sample clamped in the UTM the load is applied till the failure of the strand as shown in the figure 5. The display unit produces a graph of the stress vs strain which can be saved for further use. The result of all the different concentration and time interval are then compared in order to achieve best concentration and time interval in which a fibre should be treated in to obtain better mechanical properties.

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Fig. no. 3: UTM setup

## III. RESULTS AND DISSCUSSION

a. Comparison between untreated and treated fibre at different time interval:

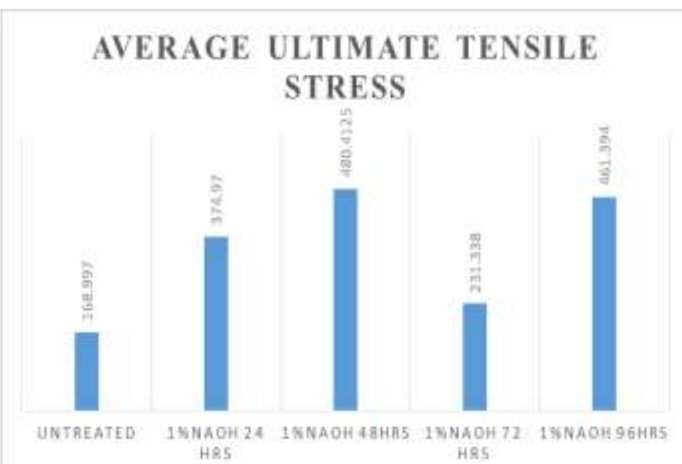


Fig no.4 Average Ultimate Tensile stress in N/mm² vs fibres

Figure 4 shows comparison between untreated fibres and treated fibres at different concentration of NaOH. The graph clearly specifies that the untreated fibre show the lowest average ultimate tensile stress when compare to treated fibres. The graph shows maximum average ultimate tensile stress is observed at 1% NaOH at 48 hours and least average ultimate tensile stress at 1% NaOH at 72 hours when compared with other treated fibres.

b. Compression between Average displacement and treated and untreated fibres

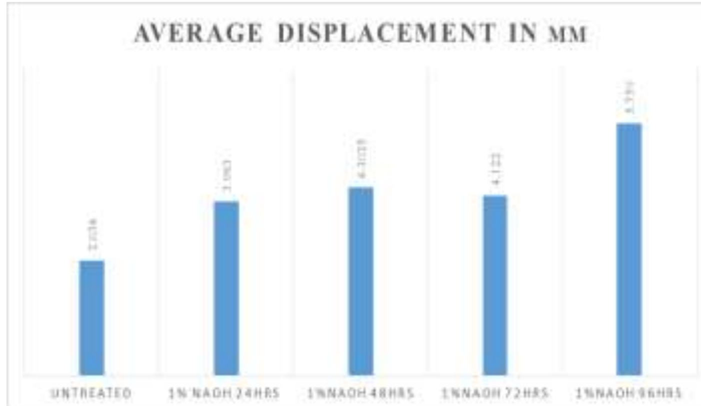


Fig no. 5 Average displacement in mm vs fibres

Figure 5 graph shows that the untreated fibre gives the least displacement among all the fibres. Maximum displacement is observed in 1% NaOH at 96 hrs. The least displacement amongst the treated fibres were observed at 1% NaOH 72 hrs.

c. Discussion

This work shows Comparison between untreated fibres and treated fibres at 1% concentration of NaOH at different time interval. The study clearly specifies that the untreated fibre show the lowest average ultimate tensile stress as well as lowest average displacement when compared to treated fibres. The study shows maximum average ultimate tensile stress is observed when fibre is treated in 1% NaOH for 48 hours and Maximum average displacement is observed when fibre is treated in 1% NaOH for 96 hrs.

## IV. CONCLUSION

The availability of Areca fibre is in large quantity and is economically available. The areca fibre is observed to have high strength to weight ratio, biodegradable properties, high stiffness and low density.

The current work shows the improvement in mechanical properties for the treated (NaOH) fibres as compared to untreated fibres. From the results it shows that the average ultimate tensile stress of untreated fibre is less when compared to treated fibres.

In treated fibres average ultimate tensile stress is maximum for fibre treated in 1% NaOH for 48 hours and average ultimate tensile stress is minimum for fibre treated in 1% NaOH for 72 hours.

From the results it shows that the average displacement of untreated fibre is less when compared to treated fibres.

In treated fibres average displacement is maximum for fibre treated in 1% NaOH for 96 hours and average displacement is minimum for fibre treated in 1% NaOH for 72 hours.

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