IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 15, Issue 6 Ver. III (Nov. - Dec. 2018), PP 62-73
www.iosrjournals.org

Investigation and Study of Mechanical Properties of Areca Shell Fiber and Palm Powder Natural Composites

Somashekhara J[1], Ramesh B T[2], Vinay Belagavi[3] & Madhu H T[4]
[1,2] *Assistant Professor, MED, Jain Institutes of Technology, Davangere, Karnataka-577003*
[3,4] *Assistant Professor, MED, Jain Institutes of Technology, Davangere, Karnataka-577003*
Corresponding Author: Ramesh B T

Abstract: *Natural fibers are considered to have potential use as reinforcing material in polymer matrix composites because of their good strength, stiffness, low cost, less weight and environment friendly. The interest in natural fiber-reinforced polymer composite materials is rapidly growing both in terms of their industrial applications and fundamental research. They are renewable, cheap, completely or partially recyclable, inexpensive, moderate weight, eco-friendly and biodegradable. In the present work an effort has been made to study the mechanical properties of Areca shell fiber, Areca palm powder and Epoxy reinforced natural composites. It is found from the result that, the mechanical properties of tensile, flexural and impact test of treated areca shell fiber composites is more compared to untreated areca shell fiber composites. In compression and hardness test the untreated areca shell fiber composites have shown better results than compare to treated areca shell fiber composites. From the investigation it is better identified that mechanical properties of Areca shell fiber and Areca palm powder composites shown better strength properties compared to commercially available Nuwood.*

Date of Submission: 26-12-2018 Date of acceptance: 11-01-2019

I. Introduction

A Composite Material is a macroscopic combination of two or more distinct materials, having a recognizable interface between them. Composites are used not only for their structural properties, but also for electrical, thermal, tribological, and environmental applications. Modern composite materials are usually optimized to achieve a particular balance of properties for a given range of applications. Given the vast range of materials that may be considered as composites and the broad range of uses for which composite materials may be designed, it is difficult to agree upon a single, simple, and useful definition. The resulting composite material has a balance of structural properties that is superior to either constituent material alone. The improved structural properties generally result from a load-sharing mechanism. Although composites optimized for other functional properties (besides high structural efficiency) could be produced from completely different constituent combinations than fit this structural definition, it has been found that composites developed for structural applications also provide attractive performance in these other functional areas as well. Thus, composites typically have a fiber or particle phase that is stiffer and stronger than the continuous matrix phase. There are, however, exceptions that may still be considered composites, such as rubber-modified polymers, where the discontinuous phase is more compliant and more ductile than the polymer, resulting in improved toughness. Similarly, steel wires have been used to reinforce gray cast iron in truck and trailer brake drums [1].

1.1 Natural Fiber Reinforced Composites

The interest in natural fiber-reinforced polymer composite materials is rapidly growing both in terms of their industrial applications and fundamental research. They are renewable, cheap, completely or partially recyclable, and biodegradable. Plants, such as flax, cotton, hemp, jute, sisal, kenaf, pineapple, ramie, bamboo, banana, etc., as well as wood, used from time immemorial as a source of lignocelluloses fibers, are more and more often applied as the reinforcement of composites. Their availability, renew ability, low density, and price as well as satisfactory mechanical properties make them an attractive ecological alternative to glass, carbon and man-made fibers used for the manufacturing of composites. The natural fiber containing composites are more environmentally friendly, and are used in transportation (automobiles, railway coaches, aerospace), military applications, building and construction industries (ceiling panelling, partition boards), packaging, consumer products, etc [2-4].Therefore natural fibers (sisal, areca, etc.) have attracted the attention of scientists & technologists for application in consumer goods, low cost housing and other civil structures. It has been found that these natural fiber composites possess good mechanical properties with low specific mass, better electrical resistance, good thermal & acoustic insulating properties. Despite the attractiveness of natural fiber reinforced

polymer matrix composites they suffer from lower modulus, lower strength & relatively poor moisture resistance compared to synthetic fiber reinforced composites such as glass fiber reinforced plastics [5].

1.2 Natural Areca Shell Fibers

Among all the natural fiber-reinforcing materials, areca appears to be a promising material because it is inexpensive, availability is abundant and a very high potential perennial crop. It belongs to the species Areca catechu L., under the family palmecea and originated in the Malaya peninsular, East India. Major industrial cultivation is in East India and other countries in Asia. In India, areca nut cultivation is coming up on a large scale basis with a view to attaining self sufficiency in medicine, paint, chocolate, Gutka, etc. It is estimated that about 6 Lakh tonnes of areca husk is available in south West-India The husk of the Areca is a hard fibrous portion covering the endosperm. It constitutes 30–45% of the total volume of the fruit. Areca husk fibers are predominantly composed of hemicelluloses and not of cellulose. In Table 1 the chemical composition of Areca fibers is shown along with few known fibers. Areca fibers contain 13 to 24.6% of lignin, 35 to 64.8% of hemicelluloses, 4.4% of ash content and remaining 8 to 25% of water content. The fibers adjoining the inner layer are irregularly lignified group of cells called hard fibers and the portions of the middle layer contain soft fibers. Table 1 compares the chemical composition of Areca fiber with some other important natural fibers. Areca fiber is highly hemicellulosic and is much greater than that of any other fibers. Coir has higher lignin content than fibers. Therefore extensive planning for the disposal of this material is required. The present use of this highly hemicellulosic material is as a boiler fuel when sufficiently dried. However for the use of these fibers as a reinforcing material for composites, a study of the chemical and physical characteristics is required [6] and [7].

Table 1 Chemical composition of natural fibers

Fiber	Lignin %	Cellulose %	Hemicellulose %
Areca	13-24.6	----	35-64.8
Maize Stalk	10-13	38-42	21-23
Coir	40-45	32-43	0.15-0.25
Sisal	10-14	66-72	12
Banana	5	63-64	19

Fig. 1 Areca shell fiber and powder

1.3 Areca Palm (Areca Catechu)

Among all the natural fiber-reinforcing materials, betel palm appears to be a promising material because it is inexpensive, availability is abundant and a very high potential perennial crop. It belongs to the species Areca catechu L., under the family palmecea and originated in the Malaya peninsular, East India. Major industrial cultivation is in East India and other countries in Asia. In India betel palm is used in the preparation of the Tiffin plates unlike paper plates. Betel palm powder is predominantly composed of cellulose and hemicelluloses. Betel palm contain 35.91% of cellulose, 26.6% of hemicelluloses, 16.6% of lignin, 9.19% of ash content and remaining 11.7% of moisture content.

1.4 Epoxy Resins

Epoxy resins are a class of thermoset materials used extensively in structural and specialty composite applications because they offer a unique combination of properties that are unattainable with other thermoset resins. Available in a wide variety of physical forms from low-viscosity liquid to high-melting solids, they are amenable to a wide range of processes and applications. Epoxies offer high strength, low shrinkage, and excellent adhesion to various substrates, effective electrical insulation, chemical and solvent resistance, low cost, and low toxicity. They are easily cured without evolution of volatiles or by-products by a broad range of chemical specie. Epoxy resins are also chemically compatible with most substrates and tend to wet surfaces easily, making them especially well suited to composites applications. Epoxy resins (ER) are one of the most important classes of thermosetting polymers which are widely used as matrices for fiber-reinforced composite

materials and as structural adhesives.The three basic elements of an epoxy resin formulation that must be understood when selecting a thermoset system are the base resin, curatives, and the modifiers. When formulating an epoxy resin for a particular use, it is necessary to know what each of these components contributes to the physical and mechanical performance of the part during and after fabrication [1]. Epoxy resin is a widely used polymer matrix for advanced composites where good stiffness, dimensional stability and chemical resistance are required.

1.5 Problem Identification

The interest in natural fiber reinforced polymer composite materials is rapidly growing both in terms of their industrial applications and fundamental research. They are renewable, cheap, completely or partially recyclable, and can be incinerated at the end of their life cycle for energy recovery as they possess a good deal of calorific value. They are also very safe during handling, processing and use. Therefore focus on the natural fibers than that of the other is given as more research work has not been done on areca palm powder and areca shell fiber reinforced composite. It looks hard to define a problem before doing an experiment. In the present work an effort has been made in order to prepare the composites using areca shell fiber and areca palm powder as reinforcement materials and study the mechanical properties such as tensile, compression, flexural, impact and hardness of that prepared polymer matrix composites.

II. Materials And Specimen Preparations

2.1 MATERIALS

In the present work following materials have been used for the preparation of specimens as per requirements. The methodology used for the preparation is also explained.

2.1.1 Matrix Material

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 as Epoxy is that, it is having a medium viscosity, non-crystallizing epoxy material, with room temperature curing properties. Atul Ltd. Lapox L–12 and hardener K–6 purchased from Yuje Marketing, Bangalore, India, 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.

2.1.2 Reinforcement Materials

Reinforcements can be both natural and man-made. Many materials are capable of reinforcing polymers. Some materials, such as the cellulose in wood, are naturally occurring products. Most commercial reinforcements are manmade. As opposed to common metal materials, fibers have anisotropic properties. In this work Areca shell fiber is used as reinforcement material and betel palm powder used as a filler material.

2.1.3 Areca shell fiber

The Areca fibers obtained from Areca shell. In the extraction process first, the shell was soaked in water for 1 days to soften the fibers. The soaking process loosens the fibers and can be extracted out easily. Finally, the fibers were washed again with water and dried at room temperature for about 3 days. The dried fibers are designated as untreated fibers. These fibers are cut to short fibers (5-10mm) for the preparation of composites. The density of Areca shell fiber is found to be 1.05 g/cm^3. The chemical composition of Areca shell fiber used in the present work was found to be as shown in Table 2.

Table2. Chemical composition of Areca shell fiber

Composition	Weight in %
Cellulose	------
Hemicellulose	35-64.8
Lignin	13-26
Moisture content	------
Ash	------

2.1.4 Areca palm powder

The betel palms are available in local region. The collected betel palm were dried in atmosphere (Sun light) for duration of two weeks and subsequently broken into small pieces. It is then converted in to fine powder form with a grinder. The formed powder was sieved and grain size chosen in the range of 425 to 500 microns randomly. The density of betel palm is found to be 0.81 g/cm^3. The chemical composition of betel palm powder used in the present work is shown in Table 3.

Table 3 Chemical composition of Areca palm powder

Composition	Weight in %
Cellulose	35.91
Hemicellulose	26.6
Lignin	16.6
Moisture Content	11.7
Ash	9.19

2.2 ARECA SHELL FIBER TREATMENT

Chemical treatment on Areca shell fiber will usually remove the moisture content thereby increasing its strength and also enhances the mechanical properties. This treatment clears all the impurities and also stabilizes the molecular orientation. In view of this, the Areca shell fiber used in the preparation of the composite is pretreated with acidic solutions. Based on the literature, the Areca shell fiber is treated with acidic solutions namely HCl (Hydrochloric acid) which have 0.1 normality. The treatment is made for time duration of 5hours. After chemical treatment the Areca shell fiber was washed thoroughly with deionised water to remove the residues of the chemical content in it. The washed Areca shell fiber is dried at room temperature.

2.3 FABRICATION

The fabrication of present work done by following steps,

- Moulds were prepared to fabricate the specimens as per the requirements of the tests to be conducted
- The inner surface of the mold was initially smeared with a releasing agent to prevent the composites from sticking on to the mold wall
- Areca palm powder, Areca shell fiber (in chopped form) with Epoxy and hardener were mixed in a container and stirred well for 5 – 7 minutes
- The prepared mixture is poured in to the prepared moulds
- The samples so prepared are kept for drying for a duration of 48 hours at room temperature
- After drying the samples were cut in accordance with ASTM standards and Specimens are prepared as per requirements

Table 4 Details of combinations used for preparation of composite specimens

Specimen Code	Specimen Composition		
	Epoxy Resin	Areca Shell Fiber	Areca Palm Powder
Untreated Areca Fiber And Areca Palm Powder			
Untreated F5% P20%	75%	05%	20%
Untreated F10% P15%	75%	10%	15%
Untreated F15% P10%	75%	15%	10%
Treated Areca Fiber And Untreated Areca Palm Powder			
Treated F5% P20%	75%	05%	20%
Treated F10% P15%	75%	10%	15%
Treated F15% P10%	75%	15%	10%

2.4 SPECIMEN PREPERATION

The composite specimens prepared were marked for required dimensions and then cut to the markings using a wire saw. The cut edges of composites were finished with emery paper in order to bring them to the exact size. 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**.**

2.4.1 Tensile Test Specimens

Tensile test specimens were prepared according to ASTM D3039 standard. The photographic view of specimen is shown in Fig. 2 below. The specimen used is a rectangular bar of length 250mm, width 25mm and thickness 6.5mm.

Fig. 2 Tensile Test Specimens Prepared by ASTM standards

2.4.2 Compression Test Specimens

Compression test specimens were prepared according to ASTM D695 standard. The photographic view of specimen is shown in Fig. 3 below. The specimen used is a rectangular bar of length 25.4mm, width 12.7mm and thickness 12.7mm.

Fig. 3 Tensile Test Specimens as per ASTM standards

2.4.3 Flexural Test Specimens

Flexural test specimens were prepared according to ASTM D790 standard. The photographic view of specimen is shown in Fig. 4. The specimen used is a rectangular bar of 130mm length, 25mm width and 6.5mm thickness.

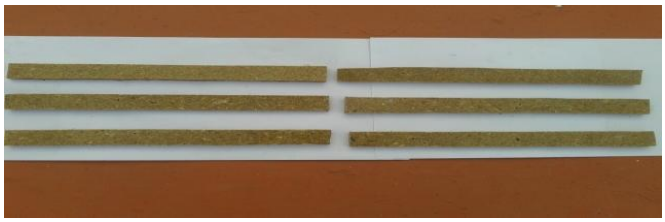

Fig. 4 Flexural test specimens as per ASTM standards

2.4.4 Impact Test Specimens

Impact test specimens were prepared according to ASTM D256 standard. The photographic view of specimen is shown in Fig. 5.The specimen used is a rectangular bar of 63.5mm length, 10mm width and 10mm thickness.

Fig. 5 Impact test specimens as per ASTM standards

2.4.5 Hardness Test Specimens

Hardness test specimens were prepared according to ASTM D785 standard. The photographic view of specimen is shown in Fig. 6. The specimen used is a rectangular bar of 10mm length, 10mm width and 6mm thickness.

Fig. 6 Hardness test specimens as per ASTM standards

III. Experimental Setup And Result Discussion

The experimental set has been made to conduct different experiments to find out different mechanical properties. In present work Universal Testing Machine was used For Tensile test, Flexural strength and compression test, Charpy test to analysis of Impact strength and vicker Hardness machine to know hardness.
In fig. 7 shows that different testing setup to analysis mechanical properties of natural composites.

Fig. 7 UTM and other testing set to find mechanical properties of natural composites

Analysis of the mechanical behaviour 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 mechanical behaviour and moisture absorption of composites.

3.1 MECHANICAL BEHAVIOUR OF COMPOSITES

In the present work, the mechanical behaviour of the composites was investigated by conducting the Tensile, Compressive, Flexural, Impact and Hardness tests. The tensile, compressive, and flexural tests were carried out by using Universal Testing Machine. The Izod test was done using impact testing machine and hardness (Rockwell hardness B) tester for finding the hardness value. The Machinability test for finding the roundness of the different compositional composite materials is carried out by using Profile Projector. The composite specimens which were prepared according to the ASTM standards tested for each property. The three different composition contents by weight ratio used are F05% P20%, F10% P15% and F15% P10% with epoxy.

3.1.1. Effect of Load on Tensile Strength of Natural Composites

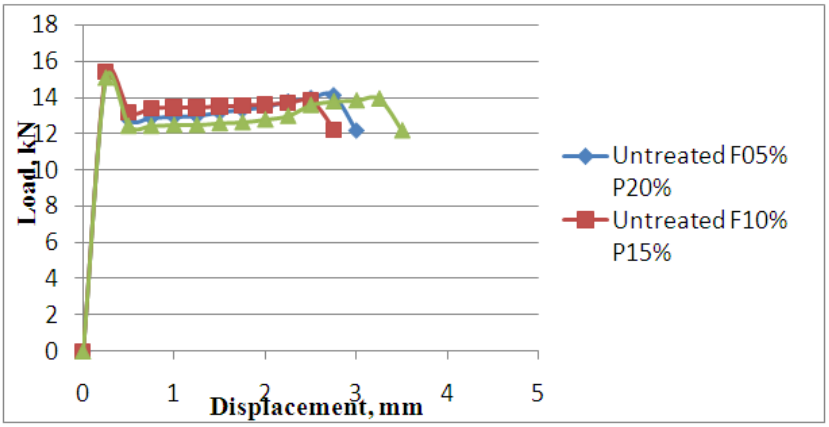

Fig. 8 Effect of Un–treated fiber content on the tensile strength of natural composites

The effect of Un–treated fiber content on the tensile strength of all the combination of composites is shown In Fig. 8. It is evident from Fig. 8 that as the load goes on increasing the deformation increases. Maximum load of 15.4kN was observed in un–treated composite specimen having composition F10% P15% compared to other two specimens. The specimen with the composition indicated above withstands maximum part of load and by consequence raise the tensile strength of composite material. This might be the reason that the matrix material is well distributed with the fiber and filler particles. However, for 15% fiber composite the tensile strength decreases as it might be due to the presence of the void content [5]. These voids are expected to

be due to the proper squeezing pressure which had not been applied on the top surface of the material which might have caused the generation of voids and also during the exothermic reaction between matrix and reinforcement material at the rate of high temperature condition the gas absorption capacity will be more. This will also influences the generation of voids.

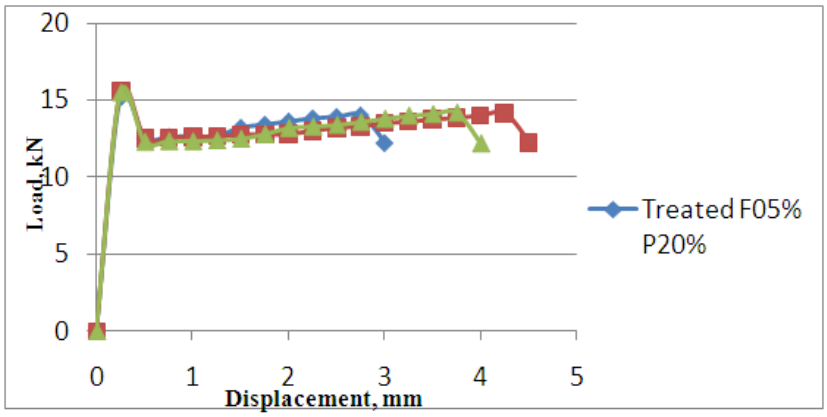

Fig. 9 Effect of HCl–treated fiber content on the tensile strength of natural composites

The Fig. 9 shows the effect of HCl–treated Areca shell fiber with three different combinations on the composite specimens. From the Fig 9 it can be observed that the composite specimen with the composition of F10% P15% sustain more load 15.6kN and more deformation compare to the other two specimens with compositions of F05% P20% and F15% P10% sustain loads up to 15.2kN and 15.5kN respectively. The specimen with composition of F15% P10% has high tensile strength compare to other two compositions of specimens because of high fiber content. The effect of alkali treatment improves the fiber strength, fiber matrix adhesion and the performance of the natural fiber composites by removing the natural and artificial impurities as well as softens the fiber which will gives high tensile strength to the fiber. This observation indicate that the fiber rich reinforced composites will sustain more tensile load and at the same time the chemical treatment of areca shell fiber allows rich bonding with the Palm powder filler by soaking the fibers in a known concentration of HCL.

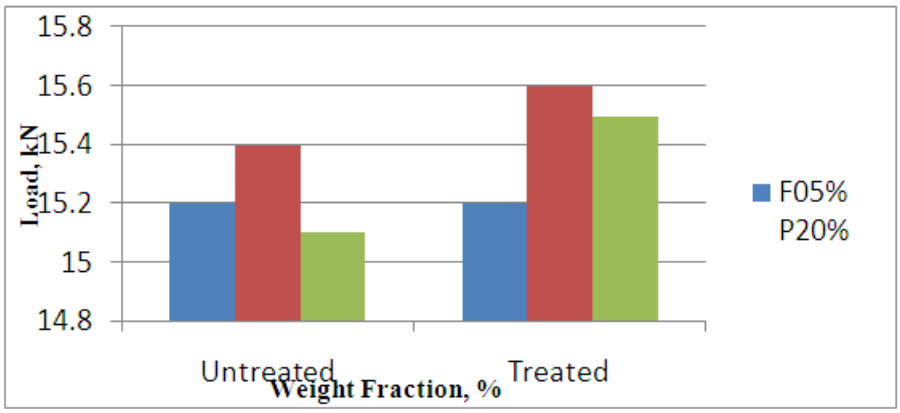

Fig. 10 Comparision of tensile strength of un–treated and treated specimens of three different combinations

The tensile properties of untreated and treated composites at different percentages of fiber and filler contents are shown in Fig. 10.Comparision of the untreated fiber composites, with the acid-treated fiber composites on observation indicate that there is no much variation in the tensile load. The composition of F10% P15% treated and untreated composites sustain the load of 15.6kN and 15.4kN respectively. This is due to the well segregation of the filler and fiber particles with the matrix and also the interfacial bonding between the fiber and matrix is high. Un-treated composites sustain more load in the order of their composition F10% P15% as first, F05% P20% as second and F15% P10% as the last compared to the treated composites again in the order F10% P15%, F15% P10%, F05% P20% respectively. The results indicate that, increase in tensile strength in treated fiber content composite assumed to be due to the increase in fiber percentage which resists the pull out.

3.1.2 Effect of Load on Compressive Strength of Natural Composites

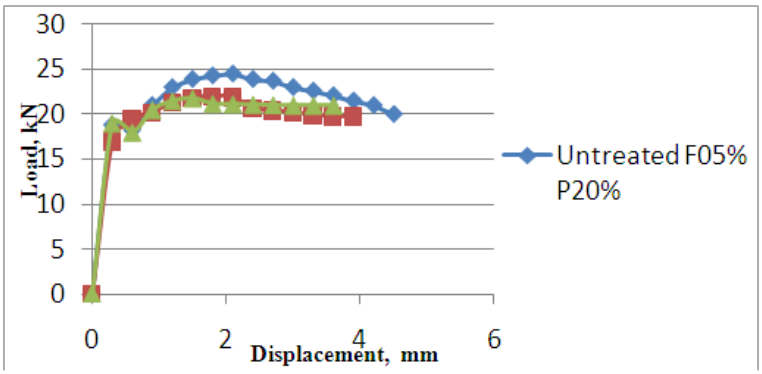

Fig. 11 Effect of Untreated fiber and untreated filler content on the compressive strength of natural composites

The compression strength of un-treated composite at three different percentage compositions of fiber and filler content is shown in the above Fig. 11. It is observed from the figure that 20% of the betel palm filler content composite exhibited high compressive load of 24.5kN and more deformation. After reaching the yield load of about 17kN, the composites start to deform at faster rate. This situation is assumed to be due to the betel palm filler content particles strengthening the interface adhesion with the matrix and fiber materials, high fiber matrix compatibility and wetting [27]. And also presumed that the matrix material which is distributed over the surface of the solid particles of the untreated fiber which gives high brittleness to the composites.

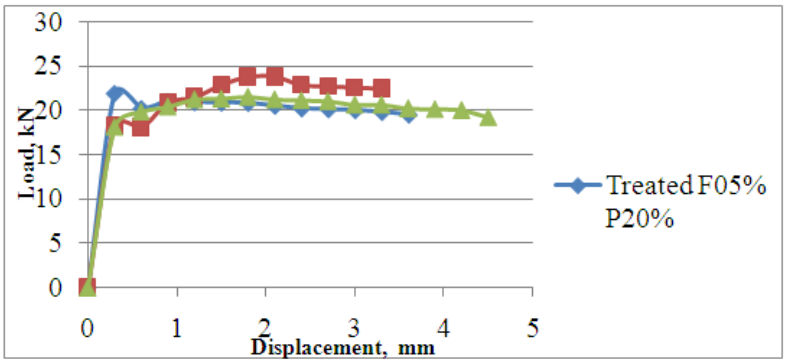

Fig. 12 Effect of Treated fiber and untreated filler content on the compressive strength of natural composites

In Fig. 12 shows the relation between the load and displacement for treated composite of different combinations under compressive load. The Fig. 12 clearly shows that load bearing capacity of the composite with treated 10% fiber content is comparatively higher than the other two composites which sustained a load of 23.75kN and its compressive strength is also higher than the rest of the composites. It may be due to high fiber-matrix compatibility, good fiber-matrix interaction.

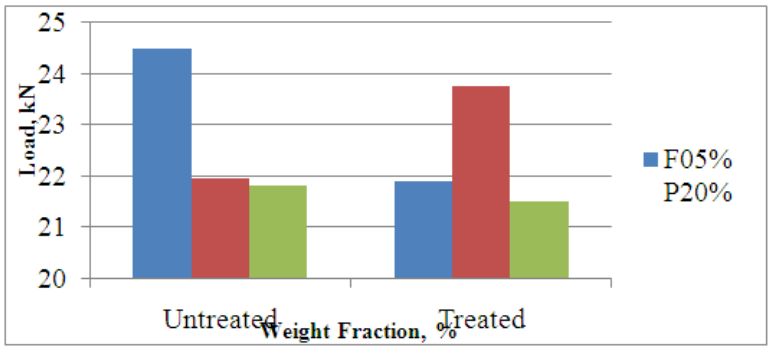

Fig. 13 Comparison of compressive strength of un–treated and treated Specimen of three different combinations

The compressive strength of three different combinations of natural composites both un–treated and treated is shown in the Fig.13 The un-treated composite with 05% fiber content observed to be having more compressive strength compared to the treated ones. This might be due to the chemical treatment effect on the fiber content. Hence the composite with treated fiber content is exhibiting decrease in compressive strength. The composite with un-treated content of composition (F05% P20%) shows more load absorbing capacity compared to the treated composite of composition (F05% P20%). This might be due to the betel palm filler content particles strengthening the interface adhesion with the matrix and fiber materials, high fiber matrix compatibility and wetting.

3.1.3 Effect of Load on Flexural Bending Strength of Natural Composites

The flexural strength of un-treated composite at three different percentage compositions of fiber and filler content is shown in the Fig. 14. The figure clearly indicates that, the variation in weight fraction of filler contents does not have greater effect on the load bearing capacity and the ability to withstand bending of the composites. The composite with F10% P15% shows maximum flexural load of 16.1kN and less deformation and F05% P20% composition composite shows comparatively less load and more deformation

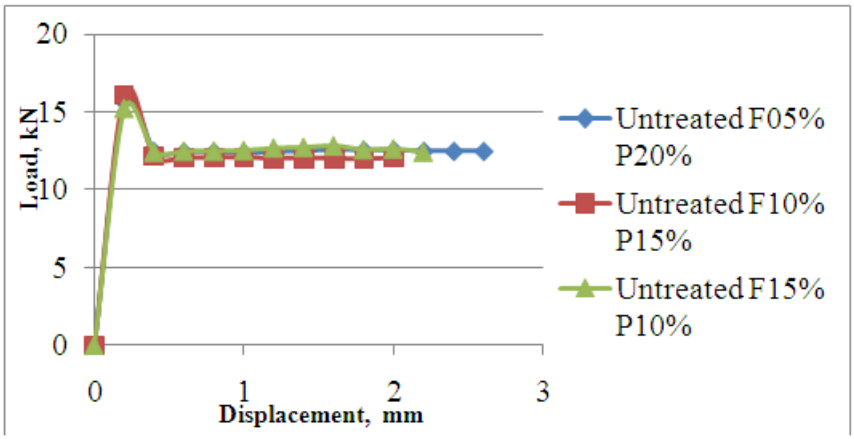

Fig. 14 Effect of Un–treated fiber content on the flexural strength of natural composites

It may be due to the reason that the improper segregation of the fiber and filler particles with the matrix material. The composite with composition of F15% P10% has shown more deformation at the yield point than the other two composites. This might be due to the reason that the fiber will deform more compare to the composite with more percentage of betel palm powder as filler. The upper portion of composite will first undergo compression and bottom portion of the composite will then deform under tension [4].

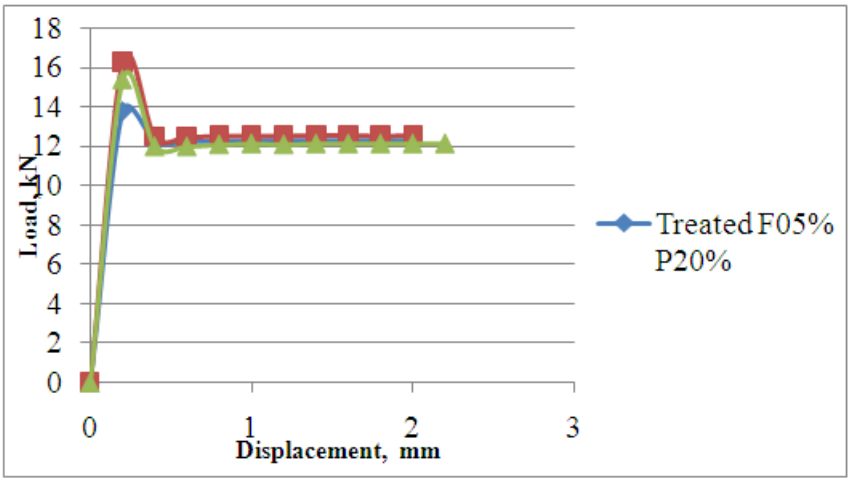

Fig. 15 Effect of Treated fiber and untreated filler content on the Flexural strength of natural composites

The Fig.15 shows the results of flexural strength testing of chemical treated specimens with different combination of composites. Fig. 5.8 shows that flexural strength increases with increase in Areca fiber content composite. The flexural strength decreases with increase in filler percentage. It was observed that 10% volume of treated fibers composite had a higher flexural strength than 05% & 15% treated composites due to high fiber-matrix compatibility, good fiber-matrix interaction & wetting. It is reasonable that enhanced fiber-matrix interaction due to high fiber-matrix compatibility and alkali treatment at 10% fabric content will lead to an increased transfer of stress from matrix to fibers and thus flexural strength increases. At 10% volume of treated fibers composite, value of the flexural strength was found to be higher and optimum than the untreated composites. This was because alkali treatments have been proven effective in cleaning fiber's surface by removing impurities from fibers, decreasing moisture sorption, enabling mechanical bonding and thereby improves matrix reinforcement interaction. Thus the alkali treatment enables and improves the fiber fitness, adhesive characteristics of the surface of the areca fibers, fiber-matrix polar interaction & wetting, hence surface offers a good fiber-matrix interface adhesion and an increase in the mechanical properties [27, 24].

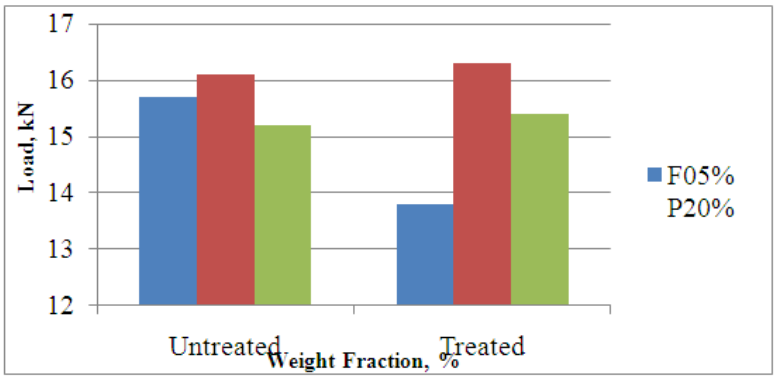

Fig. 16 Comparison of flexural strength of un–treated and treated Specimen of three different combinations

In Fig.16 shows the treated fiber having a more flexural load and deformation compared to the Untreated ones. From the Fig 5.9 it is observed that, the composition of F10% P15% Untreated and Treated composites have higher flexural load than other two composites. At 10% volume of treated fibers composite, value of the flexural strength was found to be higher and optimum than the untreated composites. This may be due to alkali treatments that had been proven effective in cleaning fiber's surface by removing impurities from fibers, decreasing moisture sorption, enabling mechanical bonding and thereby improves matrix reinforcement interaction. Thus the alkali treatment enable and improves the fiber fitness, adhesive characteristics of the surface of the areca fibers, fiber-matrix interaction & wetting, hence surface offers a good fiber-matrix interface adhesion and an increase in the mechanical properties [27, 24].

3.1.4 Effect of Load on Impact Strength of Natural Composites

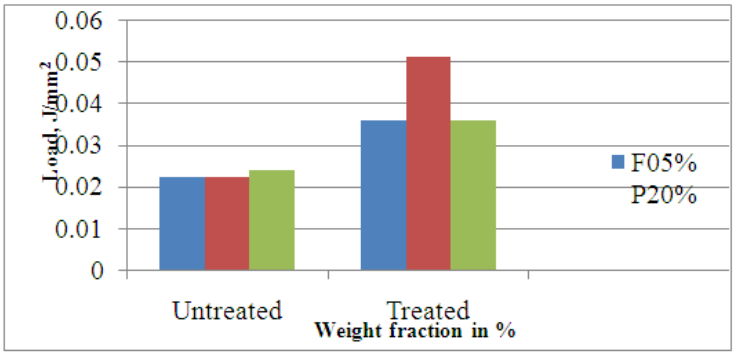

Fig. 17 Variation of impact strength of the untreated and treated three different combination natural composites

It clearly shows the comparable results of impact strength for un– treated and treated of three different combination composites. Generally impact strength found to increase with the increase of the fiber content and the maximum impact value was observed in the untreated fiber content of 15%. In case of treated combination it was observed that 10% of fiber content of the composite had higher values of the impact strength than 05%, and 15% volume of treated fiber composites. Higher impact strength of treated composites is due to a better

mechanical interlocking of the fiber-matrix, which results in the fracture of fiber at the crake-plane with less fiber pullout. As the alkali treatments have been proven effective not only in cleaning fiber's surface by removing impurities & hemicellulose from fibers but also will render the fiber surface coarser leading to better interface and interlocking between fibers and matrix blend [27]. From the above result 20% filler content of treated and untreated composites have lesser impact strength is due to the presence of so many filler ends in the composites, which could cause crack initiation and hence potential composite failure [20].

3.1.5 Effect of Chemical Treatment on the Hardness Value of Natural Composites

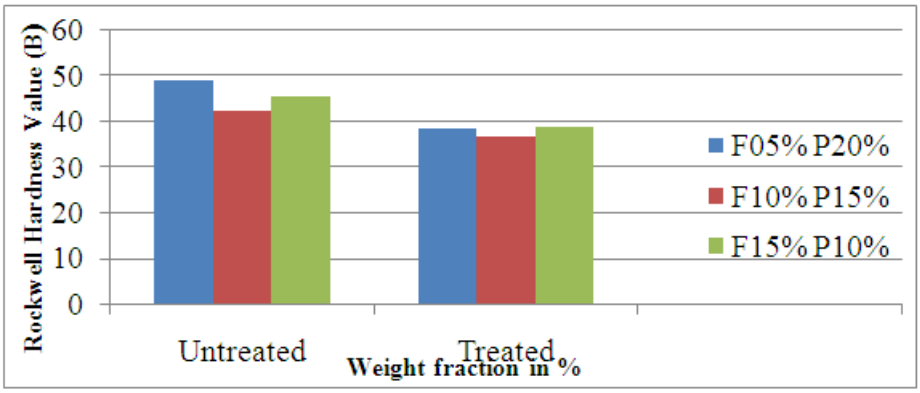

Fig. 18.Variation of Hardness value of the untreated and treated composites for three different combinations

From Fig.18 it can be observed that the hardness value increases with increase in filler content of composite. This is due to proper distribution of filler material; due to interaction of the filler with fiber in the interfacial bonding the ductile viscous is turned to brittle in nature. This is causing a continuous increase in the hardness with the increase in filler content. The 10% fiber content composite has shown a lower trend in hardness. This is due to the fact that the fiber becomes the predominant than the base material and as the percentage of fiber increases, the interaction between the fibers inside the composite increases i.e. there will be higher fiber to fiber contact which leads to poor interfacial bonding between the fiber and the matrix. Due to this poor interfacial bonding effective load transfer may not take place and leads to quick failure and such reduction in strength may be attributed to increasing porosity and air void which brought about insufficient compaction of the high fiber content mixture. The untreated fiber content composite shows maximum hardness value i.e., 49 compared to the treated composite. This might be due to the presence of high loading solid particles embedded with untreated areca shell fibers.

Table 5 Comparision Of Commercial Nuwood With Untreated And Treated Areca Shell Fiber And Areca Palm Powder – Epoxy Resin Natural Composites

Composite	Tensile Strength in N	Compressive strength in N	Flexural strength in N	Impact strength in J/mm^2	Hardness in (RHNB)
Untreated Areca Fiber And Areca Palm Powder					
Untreated F5% P20%	15200	24500	15700	0.0225	49
Untreated F10% P15%	15400	22000	16100	0.0225	42.5
Untreated F15% P10%	15100	21800	15200	0.0243	45.5
Treated Areca Fiber And Untreated Areca Palm Powder					
Treated F5% P20%	15200	21900	13800	0.03625	38.5
Treated F10% P15%	15600	23750	16300	0.051225	37
Treated F15% P10%	15500	21500	15400	0.036225	39
Commercial Nuwood	2200	2000	225	0.189	2

IV. Conclusion

Based on the results of the experimental investigation the following conclusions are drawn.

- The amount of areca shell fiber content positively affects the tensile strength of composites. The treated specimen with F10% P15% composition found to have a greater tensile load of 15.6kN and tensile strength of 0.123kN/mm^2
- The compressive load of the untreated specimen with composition F05% P20% shown greater value of 24.5kN and greater compressive strength of 0.145kN/mm^2
- The flexural load of the composites increases with increase in the amount of Areca shell fiber content. The treated specimen with F10% P15% composition found to have more flexural load of 16.3kN and Flexural strength of 0.100kN/mm^2

- The treated composite specimen with F10% P15% composition observed to be sustaining higher impact strength of 0.051225 J/mm^2 compared to F05% P20% and F15% P10% composition specimens
- Hardness increases with increase in betel palm powder content. Composites with F05% P20% Untreated composition as shown maximum hardness of 49 (HV+30) compared to F10% P15% and F15% P10% compositional specimens
- The specimen with composition of F10% P15% (Treated) shown 1.3% increase in tensile strength compared to F10% P15% (untreated)
- The specimen with composition of F05% P20% (un-treated) shown 4% increase in compression strength compared to F10% P15% (treated)
- The specimen with F10% P15% (Treated) composition found to possess 1.5% increase in flexural strength compared to F10% P15% (Untreated)
- The specimen with composition of F15% P10% (Untreated) shown 58% decrease in impact strength compared to F10% P15% (Treated)
- The composite specimen with F05% P20% (un-treated) shown 21% increase in hardness value compared to F15% P10% (treated) combination composites

References

[1]. "ASM Handbook for Composites" , ASM International Committee, Volume 21, 2001, pp. 1-2605.
[2]. Prof Pandey P C., "Composite Materials", Dept of Civil Eng, IISc, Bangalore. syllabus version 2.0 - l7, August 2004.
[3]. Abdul Khalil H P S, Firoozian P, Bakare I O, Hazizan Md. Akil and Ahmad Md. Noor., "Exploring Biomass Based Carbon Black as Filler in Epoxy Composites: Flexural and Thermal Properties" , Materials and Design, 31, 2010, pp. 3419-3425.
[4]. Alamari H and Low I., "Mechanical Properties and Water Absorption Behaviour of Recycled Cellulose Fibre Reinforced Epoxy Composites" , Polymer Testing, 31, (2012), pp.620-628.
[5]. Ali J Salaman., "Tensile and Impact Properties of Polystyrene Matrix Composites Reinforced by Palm Natural Fibers And Carbon Fibers", Academic Research International, Vol. 3, No. 2, September 2012, pp. 114-116.
[6]. Arun Kumar Rout and Alok Satapathy., " Study on Mechanical and Tribo-Performance of Rice-Husk Filled Glass–Epoxy Hybrid Composites" , Materials and Design, 41, (2012), pp. 131–141.
[7]. Cheng Jung Lina, Salim Hiziroglub, Shu Min Kana and Hsien W., **"**Manufacturing Particle Board Panels from Betel Palm (Areca catechu Linn.)", Journal of Materials Processing Technology, I 97, 2008, pp. 445–448.
[8]. Dhanalakshmi Sampathkumar, 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.
[9]. Fatima S and Mohanty A R., "Acoustical and Fire-Retardant Properties of Jute Composite Materials", Applied Acoustics, 72, 2011, pp. 108–114.
[10]. Hayes B S and Gammon L M., "Optical Microscopy of Fiber-Reinforced Composites", ASM International, www.asminternational.org., 2010.
[11]. Jinchun Zhu, Huijun Zhu, James Njuguna and Hrushikesh Abhyankar., "Recent Development of Flax Fibres and their Reinforced Composites Based on Different Polymeric Matrices" , Open Access Materials, 6, 2013, pp. 5171-5198.
[12]. Joshi S V, Drzal L T, Mohanty A K and Arora S., "Are Natural Composites Environmently Superior to Glass Fibre Reinforced Composites?", Composites: Part A, 35, 2004, pp. 371-376.
[13]. Manjunath B H and Prahlad Rao K., "Influence of Fiber/Filler Particles Reinforcement on Epoxy Composites", Vol. 3, Issue 3, May-Jun 2013, pp.1147-1151.
[14]. Mohan Kumar G C., Member IAENG, "A Study of Short Areca Fiber Reinforced PF Composites", Vol II, WCE 2008, July 2008, pp. 3-7.
[15]. 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.
[16]. 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.
[17]. Oladele I O, Omotoyinbo J A and Adewara J O T., "Investigating the Effect of Chemical Treatment on the Constituents and Tensile Properties of Sisal Fibre", Journal of Minerals & Materials Characterization & Engineering, Vol. 9, No.6, 2010, pp.569-582.
[18]. Omar Faruk, Andrzej K. Bledzki, Hans-Peter Fink and Mohin Sain., "Composites Reinforced With Natural Fibers", Progress in Polymer Science 37 : 2012, pp 1552– 1596.
[19]. Penpun Wetwitayaklung, Thawatchai Phaechamud, Chutima Limmatvapirat, Sindhchai and Keokitichai., "A Study of Antioxidant Capacity in Various Parts of Areca Catechu L", Naresuan Univercity Journal, 14 (1), 2006, pp. 1-14.
[20]. Ramachandra Reddy G, Ashok Kumar M and Chakradhar K V P., " Fabrication and Performance of Hybrid Betel Nut (Areca catechu) Short Fiber/ Sansevieria Cylindrica (Agavaceae) Epoxy Composites" International Journal of Materials and Biomaterials Applications, 1 (1), 2011, pp. 6-13.
[21]. Ratna Prasad A V and Mohana Rao k., "Mechanical Properties of Natural Fiber Reinforced Polyester Composites" , Materials and Design 32 2011, pp. 4658-4663.

Ramesh B T. "Investigation and Study of Mechanical Properties of Areca Shell Fiber and Palm Powder Natural Composites." IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , vol. 15, no. 6, 2018, pp. 62-73.