"A Review on Natural Fiber Reinforced Polymer Composites"

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Abstract-- FRP's have huge applications in the field of Automobile, Aerospace, Military applications, Building and Construction Industries (ceiling, paneling and partition boards) Etc. These applications are due to its low weight and high mechanical properties.
Fiber Reinforced Polymer composite have a very dominant role in variety of applications for their high specific strength and modulus. Lot of work is carried by various researches with different reinforcements. The reinforcement used in various applications are Fibers of Glass, Carbon, Aramid, Asbestos and Kevlar fibers. Since the natural reinforcements have less side effect and abduantly available, Lot of researches reviewed with natural reinforcements for various applications in the form of sheets, boards etc. Due to the limitations of synthetic fibers as reinforcement the use of FRP composite increased the interest of researches. The mechanical properties of a natural fiber reinforced composite depend on parameters like fiber strength, fiber length, chemical treatment and orientation in addition to fiber-matrix interfacial bond strength. Here this review article is taken as natural fiber reinforcement for development of composites.

Keywords—"Natural Fiber Composites, Chemical Treatment, Mechanical Properties, Short Fibers, Orientation"

I. INTRODUCTION

The interest in composite material is rapidly growing in terms of their industrial application and fundamental research. Over the last three decades composite materials, plastics and ceramics have been the dominant as emerging materials. A composite is defined as the combination of two or more macro constituent materials, which has essential bonding into each other such that the properties of each constituent taken separately. The constituent that is continuous and is often but not always, present in greater quantity in the composite is termed as 'Matrix' and a reinforcement of some kind, added primarily to increase the strength and stiffness of material. The reinforcement can be continuous or discontinuous, woven and random oriented. The composite properties may be the volume fraction sum of the properties of the constituents or the constituents may interact in a synergistic way resulting in improved or better properties. Apart from the nature of the constituent materials, the geometry of the reinforcement (shape, size and distribution) influences the properties of the composite to a great extent. The concentration distribution and orientation of the reinforcement also affect the properties. Composite materials can be classified as

1. Metal matrix composite
2. Ceramic matrix composite
3. Polymer matrix composite
4. Carbon Carbon Composites

Most commonly used matrix materials are polymeric. The reason for this is twofold. Polymer matrix composites are simpler. In general the mechanical properties of polymer are inadequate for much structural purpose. In particular their strength and stiffness are low compared to metals and ceramics. These difficulties are overcome by reinforcing other materials with polymers. Secondly the process of polymer matrix composites need not involve high pressure and doesn't require high temperature. Also equipments required for manufacturing. A.Fibrous Composite

A fiber is characterized by its length being much greater compared to its cross sectional area. The dimensions of the reinforcement determine its capacity of contributing its properties to the composite. Fibers are very effective in improving the fracture resistance of the matrix since a reinforcement having a long dimension discourages the growth of incipient cracks normal to the reinforcement that might otherwise lead to failure, particularly with brittle matrices.

B.Particulate Composites

In particulate composites the reinforcement is of particle nature. It may be spherical, cubic, tetragonal, a platelet, or of other regular or irregular shape. In general particles are not very effective in improving fracture resistance but they enhance the stiffness of the composite to limited extent.

Nowadays natural fibers have become superior alternatives to synthetic fibers for polymeric composites due to their advantages [12] i.e. cheap, lightweight, renewable, biodegradable, flexible in usage and naturally recyclable. More over the application of natural fiber reinforced polymeric composites are found in House construction materials, Aerospace, Panels, and Automobile parts [7].

Many attempts were made by scientists to utilize the natural fibers in the fabrication of composites. [11]Their efforts to introduce the natural fibers composites are because of the following reasons.

1. These fibers, despite their low strength can lead to composite with specific strengths because of their low density.
2. Dried natural fibers are nontoxic and eco-friendly and biodegradable and are cheap.
3. Natural fibers are abundantly available renewable resources.

I. Researchers

Within last four to five decades, there has been a rapid increase in the production of synthetic composites, those incorporating fine Fibers in various plastics (polymers) dominating the market. With the increasing global energy crisis and ecological risks, scientists all over the world are shifting their attention towards alternative solution to synthetic fiber A brief summery has been presented here about natural fiber reinforced composites and studies carried in the field of natural fiber reinforced composite materials (non-conventional composites) are limited as compared to conventional composites

Since 1990s, natural fiber composites are emerging as realistic alternative to glass-reinforced composites in many applications. Natural fiber composites are claimed to offer environmental advantages such as reduced dependence on nonrenewable energy/Material sources, lower pollutant emissions, lower green house gas emissions, enhanced energy recovery and end of life biodegradability of components. Such superior environmental performances are important driver of increased future use of natural fiber composite. India endowed with an abundant availability of natural fiber such as Jute, Coir, Sisal, Pineapple, Bamboo, Banana, etc .has focused on the development of natural fiber composites primarily to explore value-added application avenues

A brief summery has been presented here about natural fiber reinforced composites and studies carried in the field of natural fiber reinforced composite materials:

A. P. N. E. Naveen and M. Yasaswi, [01]

Conducted research on “Experimental Analysis of Coir-Fiber Reinforced Polymer Composite Materials The present work describes the development and characterization of a new set of natural fiber based polyester composites consisting of Coir as reinforcement with epoxy resin. Coir composites are developed and their mechanical properties are evaluated, at five different volume fractions and lengths. The research found that the mechanical properties have a strong association with the dynamic characteristic. Both properties are greatly dependent on the volume percentage of fibers. Composite having 5% of fiber volume showed optimum result and Tensile strength of 13Mpa, Impact strength of 17.5KJ/m^2 and Flexural strength of 35MPA are greatly influenced by Fiber length.

B. Prof C. V. Srinivasa and K. N. Bharath [02]

Conducted “Impact and hardness properties of Areca Fiber-Epoxy Reinforced Composites” In this the mechanical properties for natural fiber composites were evaluated. The extracted fiber from Areca Husk were chemically treated to get better interfacial bonding and composites were prepared with randomly oriented fibers with different fiber and matrix ratio.

The results showed that fiber volume fraction of 60:40 having curing time of 1080hours have Impact energy of 11 Joule and composite post curing time increases the mechanical properties of the composite.

C. Dhanalakshmi Sampathkumar, Ramadevi Punyamurth, Srinivasa C. V and Basavaraju Bennehalli [03].

Carried out experiment on “Effect of Chemical Treatment on Water Absorption of Areca Fiber” The investigation on the effect of alkali-treatment and acetylation on water absorption characteristics of single areca fiber has been carried out. The results indicate that the Acetylation of areca fibers drastically reduces the water absorption whereas alkali treatment of areca fibers improves the water absorption.

D. Srinivasa Chikkol Venkateshappa, Basavaraju Bennehalli, Mownesh Gadde Kenchappa, [04].

"Flexural Behaviour of Areca Fibers Composites" A study has been carried out to evaluate physical and flexural properties of composites made by Areca husk fibers with a randomly distributed orientation of fibers.Results concluded that treated Fibers with volume fraction of 60:40 has optimum bending strength of 85 Mpa.

E. L.Yusriah, S.M Sapuan, E.S Zainudin, M. Mariatti [08].

Exploring the potential of Betel Nut Husk Fiber as Reinforcement in Polymer Composites" carried investigation on the effect of maturity of fiber (unripe, ripe and dried).Fiber length and diameter were decreased with increasing maturity stage from raw to ripe which increases density. Water absorption is found to be very less in dried fiber .Mechanical properties for different maturity stage has been carried out. Highest Moisture content was found in ripe and lowest in dried BNH.

F. Padmaraj N H,M Vijay Kini, B Raghuvir Pai, B Satish Shenoy [09].

"Development of Short Areca fiber reinforced Biodegradable composite material" carried a study on development of short areca fiber reinforced biodegradable composite material, where fibers are immersed in water for 72 hours to extract fibers. Extracted fibers are treated with alkaline solution and washed with running water thoroughly to remove excess solution and found that Tensile strength was 45.29N.

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H. Srinivas Chikkol Venkateshappa, Suresh Yalaburgi Jayadevappa & Prema Kumar Wooday Puttiah [10].

"Mechanical behaviour of areca fiber reinforced epoxy composite" in the present work mechanical properties of composites obtained using areca fiber in epoxy matrix is investigated. Fibers from areca husk is extracted and are alkali treated with KOH solution. Specimens are creation by varying weight ration and fibers are randomly oriented. Results: curing time is increased and it is found that mechanical properties are greatly influenced by alkali treatment; curing time etc for 60:40 volume fraction treated fibers flexural load was 2000n and flexural strength for 1080hours curing time was 60 mpa

I. G.C.Mohan Kumar [11].

"A study of short Areca fiber reinforced Phenol; Formaldehyde Composites" Mechanical properties on extracted fibers from Areca husk are determined and compared with Coir. Areca fibers are chemically treated and study on its strength is carried out Composite laminates of randomly distributed fibers was prepared with phenol formaldehyde and tensile test, moisture absorption test were carried out. Result: The strength of natural areca husk fibers were determined and found to be 101.85 Mpa

J. Olusegun David Samuel, Stephan Agho, Timothy Adesoye Adekanye [21].

"Assessing Mechanical Properties of Natural Fiber Reinforced Composites for Engineering Application "carried out exp to determine mechanical properties of different natural fibers. And found e glass laminates has tensile strength of 65Mpa and bending strength of .5Mpa

K. B.F. Yousif, Nirmal Singh Gill, Saijod T.W.Lau, Alvin Devadas [12].

"The potential of using Betelnut fibers for Tribo-polyester composites considering three different orientation", carried out an attempt to use fibers of betel nut as reinforcement for tribo-polyster composite in bearing application. They used randomly distributed chopped fibers and 17 layers of Polyester; composite was fabricated by using hand lay–up technique. Adhesive behavior and frictional behavior of composite were studied against a polished stainless steel counterface using BOD. In addition to that orientation of fiber layers with respect to sliding direction of counterface was considered.

L. K.N.Bharath, R.P. Swamy, A.M.Rajesh [13].

"Experimental Investigation On Biodegradable and Swelling Properties Of Natural Fibers Reinforced Urea Formaldehyde Composites", Investigated on biodegradable and swelling properties of different weight fraction of randomly distributed Areca fiber and Maize Powder reinforced Urea Formaldehyde composite. Areca husk fibers were chemically treated with dilute NaOH solution. Composites were prepared by hydraulic press and were cured for longer time. It is slower process Areca fiber and Maize powder do not decompose at faster rate. Thus this experiment shows that water absorption is significantly less when compared to wood based particle board.

M. Srinivas C.V, Bharath K.N [14].

"Effect of Alkali Treatment on Impact behaviour of Areca Husk fibers Reinforced Polymer Composites", A study has been carried out to evaluate Impact properties of composite made by Areca fibers reinforced Urea Formaldehyde, fibers from Areca husk were alkali treated with Potassium Hydroxide to obtain better interfacial bonding between fibers and matrix. Composites were produced by [CMT] with various process parameters such as fiber condition, loading percentage. It is observed that treated Areca fiber reinforcement increases impact strength when compared to untreated fiber.

N. Girish.C Sajnjeevamurthy Gunti Rangasrinivas, Manu.S[15].

In this investigation areca husk fibers and tamarind fruit fibers are reinforced with epoxy matrix and composite have been developed manually by hand layup technique. Fibers were treated with NAOH for better matrix adhesion. These composites were subjected to mechanical test. The result showed increase in tensile strength as the fiber percentage increased and good flexural strength of 48Mpa for 60:40 volume fraction has been observed for treated fibers.

O. S.Ragavendra, Lingaraju,P Balachandra Shetty, PG Mukunda [22].

"Mechanical Properties of Short Banana Fiber Reinforced Natural Rubber Composites", In this Composites are made using short banana fibers and natural rubber. Composites are prepared by vulcanizing Technique. Results Increase in fiber content increases tensile strength and incorporation of fiber into rubber matrix increases the hardness of the composite. Composites made from 15mm length shows maximum tensile strength and good tear strength.

P. Vivek Mishra, Sandhyarani Biswas [23].

"Physical and mechanical properties of Bi-Directional Jute Fiber Epoxy composites" In this the development and characterization of a new set of natural fiber based polymer composites consisting of bidirectional jute fiber mat as reinforcement and epoxy resin as matrix is used .Exp were carried out to study effect of fiber loading on physical and mechanical behaviour of these composites .Results shows that Hardness, Tensile and Impact strength of Jute-Epoxy composites increases with the increase in fiber loading.

Q. Supreeth S, Vinod B, Dr.L.J Sudev [24].

"Influence of fiber length on the tribological behavior of short PALF reinforced Bisphenol-A Composite", Present work describes that PALF was extracted from raw pineapple leaf, it was then chemically treated and dried in hot air oven. Composites are prepared by using Bisphenol-A composite using hand lay-up process with fiber length less than 15mm and 30% volume fraction. Result: Fiber length of 2mm, 4mm, 6mm, 8mm, 10mm, 12mm and 14mm was subjected to wear test by varying load and it was observed that the fiber length greatly influences the wear properties of reinforced composites.

R. M. Sumaila, I.Amber, M. Bawa [25].

"Effect of fiber length on the physical and mechanical properties of random oriented non woven short banana fiber epoxy composite", Investigation of Banana fiber length on the physical and mechanical properties of banana fiber/Epoxy composite were investigated. Composites are prepared by using Hand lay-up technique for five different samples by varying length of fiber. Tensile modulus, Mean density, Percent moisture absorption, void content, Flexural strength and Modulus of the composite were analyzed. Result: showed that with increase in fiber length void content, moisture absorption and compression strength increased. Tensile strength of 67.2Mpa and Tensile Modulus of 653.07Mpa was achieved.

II. Conclusion

The Fiber reinforced Polymer composites for different orientation of fibers, with/without chemical treatment and influence on curing time on the mechanical properties has been discussed. Hence a new class of areca sheath fiber reinforced polymer composite is a good substitute for natural fibers like Banana, Cotton, and Sisal etc is confined. We are in view of improving the mechanical properties of composites by using areca sheath fiber of different length with a volume fraction of 60:40 of which fibers are in the form of woven or random oriented with/without chemical treatment reinforced with epoxy matrix.

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