GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

A REVIEW ON PROPERTIES OF NATURAL HYBRID FIBER COMPOSITES

Mr.Anand K.A[*1] & Dr. Rathnakar. G[2]
[*1]Department of Mechanical Engineering, Sai Ram College of Engineering, Anekal, Bangalore, India
[2]HOD Department of Mechanical Engineering,ATME,Mysore, India

ABSTRACT

Natural fiber composites today are used for various applications including engineering and household applications which are proving to be high in strength to weight ratio. This project focuses on using banana stem fiber along with coconut leaf sheath as a sandwich hybrid composite material. Treated fiber of Coconut leaf sheath herein known as CLS and treated fiber composite of CLS and Banana stem Fiber hybrid composite is taken for study and comparison of properties between the two. The hybrid composite consists of sandwich of coconut leaf sheath and banana stem fiber as the reinforcement and by using the phenol formaldehyde as the matrix material. The untreated hybrid composite is then treated by using sodium hydroxide for increase in its wet ability properties. In this process the hybrid composite is treated with 5% sodium hydroxide for about one hour and the specimen is prepared by using hand layup technique and a hot press. The hybrid composite form 60% and polyformaldehyde is 40% of the weight fraction respectively of the full entire composite material. The tests proposed to be conducted are for the chemical, mechanical, Fourier Transform Infrared Spectroscopy (FTIR) and Flammability properties of Treated hybrid composite and treated CLS to be studied and analyzed. Then the treated specimens are analyzed and compared through Scanning Electron Microscope to study about its adhesion between fiber and resin matrix and surface morphology.

KeyWords: Natural fiber composites, mechanical properties, surface morphology.

I. INTRODUCTION

There are basically two types of fibers: natural fibers and synthetic fibers. Incorporation of fibers into a polymer is known to cause substantial changes in the mechanical properties of composites. Man made fibers using glass, carbon, boron etc. are being used as reinforcing materials in the Fiber-reinforced plastics (FRP) which have been widely accepted as materials for structural and non-structural applications. The main reason for the interest in FRP is due to their specific modulus, high stiffness, and strength to weight ratio compared to other conventional materials. However, these materials are prohibitively expensive in their use for other general purposes and applications. Therefore, it is worthwhile to take natural fibers as reinforcements as they are an attractive research area because they are eco-friendly, inexpensive, abundant, renewable, lightweight, and possess low density, high toughness, high-specific properties, and biodegradability. They are nonabrasive to processing characteristics and lack residue upon incineration. Therefore, a natural fiber can serve as reinforcements not only by improving the strength and stiffness but also by reducing the weight of the resulting bio-composite materials, although the properties of natural fibers vary with their source and treatment. Recent reports indicate that plant fibers can be used as reinforcement in polymer composites, replacing to some extent, more expensive and non-renewable synthetic fibers. Recent reports indicate that plant fibers can be used as reinforcement in polymer composites, replacing to some extent, more expensive and non-renewable synthetic fibers. Among all fibers, natural fibers have gained substantial importance as reinforcements in polymer matrix composites.

In this present work Natural Fiber Composites will be prepared using Phenol Formaldehyde as the matrix material and coconut leaf sheath (CLS) and banana fiber as Reinforcement material. The matrix materials are treated with NaOH for the Alkali treatment. The fabrication procedure includes the Hand Layup Technique and hot press mechanism to prepare the treated (T) hybrid fiber reinforced composite boards. The specimens are prepared as per the ASTM standards and various tests are proposed to be conducted to know the chemical, mechanical, Fourier Transform Infrared Spectroscopy (FTIR) and Flammability properties and Scanning Electron Microscope to study about its adhesion between fiber and resin matrix and surface morphology of Treated composites.

II. A REVIEW ON NATURAL FIBERS AND COMPOSITES

1. D. Chandramohan1 & .K. Marimuthu[1] This paper focuses on use of natural fibers which can replace manmade fibers constituting composite materials. The paper describes the use of plastic and ceramic composites that has been used for almost over 30 years. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications. The author stresses the need for a more cost effective and eco friendly composite while replacing the man made composites. This review paper discuss about worldwide review report on natural fibers and its

applications. Also, this paper concentrates on biomaterials progress in the field of orthopaedics. An effort to utilize the advantages offered by renewable resources for the development of biocomposite materials based on bio epoxy resin and natural fibers such as Agave sisalana; Musa sepientum; Hibiscus sabdariffa and its application in bone grafting substitutes.

Some of the merits as described by the author while comparison to the conventional composites is given below.

- Tensile strength of composites is four to six times greater than that of steel or aluminium (depending on the reinforcements).
- Improved torsional stiffness and impact properties. Higher fatigue endurance limit (up to 60% of ultimate tensile strength).
- 30% - 40% lighter for example any particular aluminium structures designed to the same functional requirements. Lower embedded energy compared to other structural metallic materials like steel, aluminium etc.
- Composites are less noisy while in operation and provide lower vibration transmission than metals.
- Composites are more versatile than metals and can be tailored to meet performance needs and complex design requirements.

Coconut leaf Sheath as reinforcement increasing the Mechanical and thermal Properties

2. Obi Reddy K, Sivamohan Reddy G, Uma Maheswari C, Varada Rajulu A, Madhusudhana Rao K [2] The author studied on Structural characterization of coconut tree leaf sheath fiber reinforcement. In this paper they have conducted tests on coconut palm tree leaf sheath fibers. Tests conducted were FTIR spectral analysis, Chemical, SEM, X-ray and thermo gravimetric methods and concluded based on tests conducted were as follows

- The FTIR and chemical analyses indicated lowering of hemi-cellulose content by alkali treatment of the fibers.
- The X-ray diffraction revealed an increase in crystallinity of the fibers on alkali treatment.
- The thermal stability of the fibers was found to increase slightly by alkali treatment.
- The tensile properties of these fibers increased on alkali treatment.

Thermal and Morphological behavior on Cellulose nanowhiskers from coconut husks

3. M.F. Rosa, E.S. Medeiros, J.A. Malmonge, K.S. Gregorski, D.F. Wood, L.H.C. Mattoso, G.Glenn, W.J. Orts, and S.H. Imam [3] studied on Cellulose nanowhiskers from coconut husk fibers: Effect of preparation conditions on their thermal and morphological behavior. In this paper they have conducted tests on coconut husk fibers. Tests conducted were thermal and morphological behavior, Fourier transform infrared spectroscopy (FTIR), transmission electron microscopy (TEM), thermo gravimetric analysis (TGA) and X-ray diffraction. Conclusion based on tests conducted were as follows

- It was possible to obtain ultrathin cellulose nanowhiskers with diameters as low as 5 nm and aspect ratio of up to 60.
- A possible correlation between preparation conditions and particle size was not observed.
- Higher residual lignin content was found to increase thermal stability indicating that by controlling reaction conditions one can tailor the thermal properties of the nanowhiskers.
- Cellulose nanowhiskers can be successfully prepared from coconut fibers by acid hydrolysis.
- Treated Banana Stem Fibers as composite reinforcement

Coconut Leaf Sheath

Alkali treatment and its effect on tribological properties of naturally woven coconut sheath and Banana Stem Fibres

4. Siva, JT Winowlin Jappes, Z Szakal , J Sukumaran[4]. The author stresses the great interest taken in the recent years of the interest natural fibres have drawn for its bio-degradability, low cost and its availability in nature. They go on to explain how among all the different types of natural fibers available , naturally woven coconut sheath fibres are one of the recently explored alternatives for synthetic fibres. They describe the increased mechanical and reinforcing properties of the fibre when treated with Alkali . The applications are also mentioned by the authors such as Tribological applications like gears, cams, bearings, etc. which can be benefited from such composites. In most cases chemical treatment are done favouring the structural properties however, their influence on tribological properties are rather not considered. In the current research, the authors used hybrid composites (polyester resin with naturally woven coconut sheath (N) and glass fibres (G)) and they were tested against hardened steel counterface in a pin on disc configuration. Tests were performed at 40 N normal force and 3.5 m/s sliding velocity. From the results all hybrid combinations except (NNN) showed degrading wear properties with the alkaline treatment. The friction properties were modified by having low friction coefficients for all combinations except NGN and GGG hybrids. From the observed SEM images the surface morphology of NNN hybrid significantly differs from the rest of the combinations in both treated and untreated specimens. The partial removal of individual phase (resin) prevails in untreated specimen for which the fibres are highly visible. However, such phenomenon is not dominant in the alkali treated material showing better reinforcing behaviour complimenting low friction properties. The alkali treated specimen has reduced fibre size comparing the untreated specimen which results in low wear resistance. Compromise between friction and wear properties between each other the untreated fibres are best suited for tribological applications. Furthermore, investigations on treatment process and other treatments might have some influence in tribological behaviour. Natural fiber composites are nowadays being used in various engineering applications to increase the strength and to optimise the weight and the cost of the product. Various natural fibres such as coir, sisal, jute, coir and banana are used as reinforcement materials. In this paper both treated and untreated banana fiber are taken for the development of the hybrid composite material. The untreated banana fiber is treated by sodium hydroxide to increase the wettability. The untreated banana fiber and sodium hydroxide treated banana fiber are used as reinforcing material for both Epoxy resin matrix and Vinyl ester resin matrix. Coconut shell powder is used along with both untreated and treated banana fiber as a reinforcing material. In this process the banana fiber is treated with 5% of sodium hydroxide for one hour and the specimen is fabricated by hand moulding process. The mould used for fabricating the

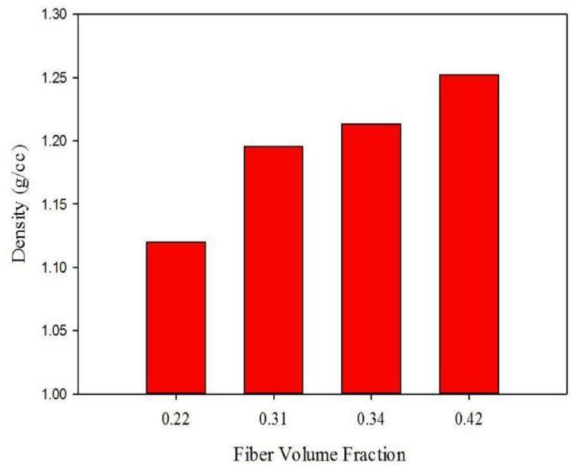
ISSN 2348 – 8034
Impact Factor- 4.022

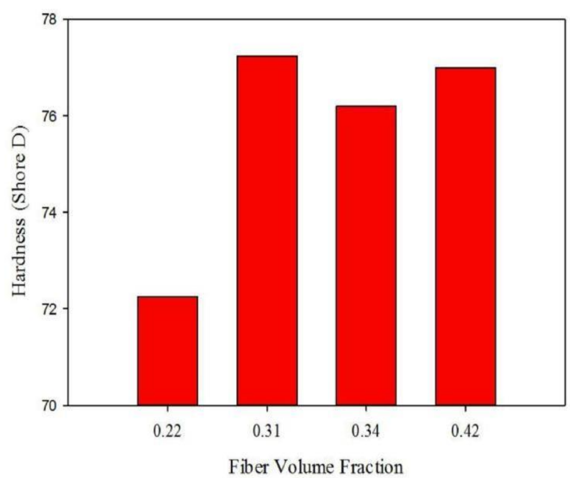
hybrid composite material is made up of aluminium with a debonding agent applied on the inner side. The banana fiber content is kept constant to 30% of weight fraction of entire composite material. The variation in mechanical properties are studied and analyzed. Here, the tensile strength has calculated by universal testing machine, impact strength has calculated by pendulum impact tester and flexural strength has calculated by universal testing machine with flexural test arrangement of the specimen. Then the treated and untreated specimens are analyzed and compared through Scanning Electron Microscope to study about its adhesion between fiber and resin matrix and surface morphology

Effect of fiber volume fraction on the mechanical properties of coconut sheath/USP composite

5. Siva , Winowlin Jappes , Sankar , Amico and Ravindran [5] .The author describes about the high specific strengths and less processing requirements due to which most of the plant based fibers are become center of research. This work used one of the novel reinforcements viz. “coconut sheath”. This reinforcement is directly drawn from the bottom portions of the coconut tree followed by minimum pre-processing before being used. Fiber volume fraction (FVF) is one of the most important factor when composite is in concern. The optimal level of reinforcement only can exhibit good bearing property. In this work, there four different fiber volumes were practiced in order to find the optimal fiber volume fraction. Density and hardness were taken as a measure for rheological properties, where flexural, ILSS and impact tests for mechanicalproperties. Result shows that, the trend in all the properties increased as a function of increase in fiber volume fraction except for impact strength

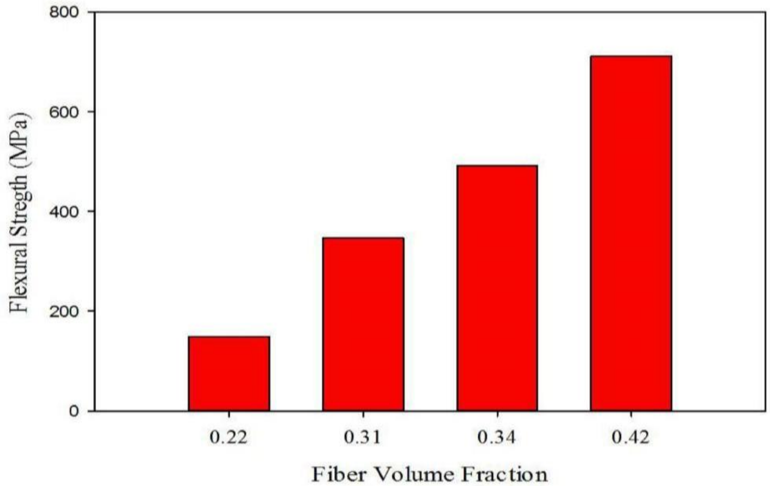
Effect of fiber volume on density and hardness


1.30
1.25
1.20
1.15
1.10
1.05
1.00
Density (g/cc)
0.22
0.31
0.34
0.42
Fiber Volume Fraction


78
76
74
72
70
Hardness (Shore D)
0.22
0.31
0.34
0.42
Fiber Volume Fraction

ISSN 2348 – 8034
Impact Factor- 4.022

Effect of Fiber Volume Fraction on Flexural Strength



Fourier Transform Infra-Red Spectroscopy and Chemical Resistance of Untreated and Alkali Treated Coconut Leaf Sheath Fiber Reinforced Polymer Composites

6. K. N. Bharath,S. Basavarajappa [6] .The author investigates the fourier Transform Infrared pectroscopy(FTIR0 and chemical resistance properties on CLS reinforced phenol formaldehyde composites. Naturally woven coconut leaf sheath composites were prepared in both NaOH treated and untreated forms with volume fraction of 60% of sheath and 40% of Phenol Formaldehyde resin. CLS were chemically treated using 5% of NaOH and composite boards were made using a hydraulic hot press at 1400C. FTIR test was conducted for both treated and untreated CLS fiber composites. And it was found that, due to chemical treatment of fibers reduction in lignin and hemicellulose content was observed. The chemical resistance of alkali treated and untreated CLS composites were measured by chemical absorption and chemical thickness swelling methods.Treated and untreated composite samples were then placed in 1N of saline, Hcl, HNO3 and H2SO4 separately. It is also observed that, saline and Hcl have been absorbed more in case of untreated composites and HNO3and H2SO4 is absorbed more in treated composites. These tests were done to know that, these composites can be used in manufacturing products which gives better chemical resistance.

Study of properties of banana fiber reinforced composites

7. J.Santhosh, N.Balanarasimman, Chandrasekar, S.Raja[7].The author experiments with both treated and untreated banana fiber for the development of hybrid composite material. The untreated banana fiber is treated by sodium hydroxide to increase the wet ability. The untreated banana fiber and sodium hydroxide treated banana fiber are used as reinforcing material for both Epoxy resin matrix and Vinyl ester resin matrix. Coconut shell powder is used along with both untreated and treated banana fiber as a reinforcing material. In this process the banana fiber is treated with 5% of sodium hydroxide for one hour and the specimen is fabricated by hand molding process. The mould used for fabricating the hybrid composite material is made up of aluminum with a debonding agent applied on the inner side. The banana fiber content is kept constant to 30% of weight fraction of entire composite material. The variation in mechanical properties are studied and analyzed. Here, the tensile strength has calculated by universal testing machine, impact strength has calculated by pendulum impact tester and flexural strength has calculated by universal testing machine with flexural test arrangement of the specimen. Then the treated and untreated specimens are analyzed and

compared through Scanning Electron Microscope to study about its adhesion between fiber and resin matrix and surface morphology

Design and fabrication of a multipurpose table using a composite of epoxy and banana pseudostem fibres

8. S.M. Sapuan, N. Harun1, and K.A. Abbas[8].This paper describes the fabrication of a multipurpose table using banana trunk fibre-woven fabric-reinforced composite material. The aesthetic value coupled with strength and mechanical properties make banana trunk fibre-woven fabric-reinforced composites a suitable material for furniture making. Design and fabrication details using hand lay up process are described. Design of composite multipurpose table (height = 430mm and side of rectangular table top = 400 mm).

III. MECHANISM OF HOT PRESS

A hot press is used to prepare the boards. The working principle of this press is, the material from which board is to be prepared is compressed at an appropriate temperature and pressure. This setup is kept for known duration of time The mould is placed in hydraulic press, which is maintained at 150˚C, and then a pressure of 20 bars is applied. The set up

is maintained undisturbed about an hour. After an hour, the mould is taken out and allowed to cool for half-an-hour and remove the composite board from the mould.

ISSN 2348 – 8034
Impact Factor- 4.022

IV. HAND LAYUP TECHNIQUE

We Pour the calculated amount of phenol formaldehyde resin over the surface where working carrying out. By squeegee and spread the resin over the surface. Then we place the reinforcement leaf sheath in place at the proper orientation called for in the plans. Care is to be taken not to distort the leaf sheath. Protect hands with hand gloves and ensure the leaf sheath is in the proper place. Then, using a squeegee we begin to press gently from the centre of the sheath making sure that the squeegee moves in the same directions as the fibers of the leaf sheath. We Keep the fibers straight and press the fabric into the resin while working the resin up through the leaf sheath. Care is taken not to distort the fibers. Ether brush or a roller will be used to assist in this process. When the layer appears to have a nice even sheen that is flat, it will have a good lay-up. If we do not want any air bubbles, work air bubbles to the edge of the laminate to make them disappear. We will also use a brush that has been trimmed to stipple resin into areas that do not appear to have proper coverage or into problem areas. The layup assembly will then be pressed in a press. The excess resin will be allowed to squeeze out.

V. CONCLUSION

In the present experimental work, treated CLS fiber phenol formaldehyde reinforced composite materials and treated CLS fiber and banana stem fiber phenol formaldehyde reinforced composite materials will be tested and analyzed by chemical, FTIR, Flammability and Mechanical tests.

In the above papers there was no experiments done by using both banana stem fiber and CLS as a sandwich composite materials together. Since these materials are eco friendly and bio degradable this composite material can be used as laminate for plywood or particle boards where now days sheets of wood are used for the same. We assume that the mechanical properties will increase when compared to treated CLS composite. Now days Banana stem fiber are used in furniture making. Similarly the chemical resistance must increase and and flame propagation rate is calculated to decrease .The use of CLS along with Banana stem fiber will make use of materials that otherwise is just thrown away or used as fuel for fire ,it will decrease the need for wood from trees since both CLS and Banana stem fiber are just wasted after the tree or plant has served its purpose. Since individual strands are taken and woven and then treated in the case of Banana stem fiber there will be a decrease in its moisture content which will increase its crystallinity thereby the molecules are closely packed which lowers the permeation of water into them

REFERENCES

1) *Chandramohan1*& .K. Marimuthu2 A review on natural fibers IJRRAS 8 (2) ● August 2011 /Volumes/Vol8Issue2/*
2) *Obi Reddy K, Sivamohan Reddy G, Uma Maheswari C, Varada Rajulu A, Madhusudhana Rao K Coconut leaf Sheath as reinforcement increasing the Mechanical and thermal Properties*
3) *M.F. Rosa a,b, E.S. Medeiros b,c, J.A. Malmonge d, K.S. Gregorski b, D.F. Woodb, L.H.C. Mattoso c, G. Glenn b, W.J. Orts b, S.H. Imamb, Cellulose nanowhiskers from coconut husk fibers: Effect of preparation conditions on their thermal and morphological behaviour Carbohydrate Polymers 81 (2010) 83–92*
4) *Siva1, JT Winowlin Jappes2, Z Szakal 3, J Sukumaran4 alkali treatment and its effect on tribological properties of naturally woven coconut sheath polyester composite*
5) **Siva I1, Winowlin Jappes J T2, Sankar I3, Amico S C4 and Ravindran D3 effect of fiber volume fraction on the mechanical properties of coconut sheath/usp composite Journal of Manufacturing Engineering, March, 2013, Vol. 8, Issue. 1, pp 060-063*
6) *K. N. Bharath1, a*, S. Basavarajappa2, b1 Fourier Transform Infra-Red Spectroscopy and Chemical Resistance ofUntreated and Alkali Treated Coconut Leaf Sheath Fiber ReinforcedPolymer Composites Applied Mechanics and Materials Vols. 766-767 (2015) pp 205-210*
7) *J.Santhosh1, N.Balanarasimman2, R.Chandrasekar3, S.Raja4 study of properties of banana fiber reinforced composites. IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308*
8) *S.M. Sapuan1*, N. Harun1, and K.A. Abbas2 Design and fabrication of a multipurpose table using a composite of epoxy andbanana pseudostem fibres Journal of Tropical Agriculture 45 (1-2): 66–68, 2007.*