FABRICATION & CHARACTERIZATION OF PINEAPPLE FIBER REINFORCED EPOXY COMPOSITE

Anurag Shirke[1], Jaideep Narayankar[2], Mohammad Uwais Shaikh[3], Tukaram Satpute[4], Sreejith S.[5]

[1]Student, Saraswati College of Engineering, India, anuragshirke573@gmail.com
[2]Student, Saraswati College of Engineering, India, jaideepn43@gmail.com
[3]Student, Saraswati College of Engineering, India, skmdawais@gmail.com
[4]Student, Saraswati College of Engineering, India, tukaramsatpute17@gmail.com
[5]Professor, Saraswati College of Engineering, India,

Abstract .

This paper deals with the making of the bio-composite material which can replace the composite materials that are made from petroleum products. The bio-composite materials are made from natural materials which eco-friendly and can be easily used. Composite materials (also called composition materials or shortened to composites) are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter or less expensive when compared to traditional materials. In the last decades, the use of natural fibers as reinforcement in polymeric composites for technical application has been a research subject of scientist. Interest in natural fibers has increased worldwide due to their low cost, low density, hardness, higher fatigue endurance, good thermal and mechanical resistivity and to their environmental friendliness. The Asian markets have been using natural fibers for many years e.g., jute is a common reinforcement in India. Natural fibers are increasingly used in automotive and packaging materials. India is an agricultural country and it is the main stay of Indian economy. Thousands of tons of different crops are produced but most of their wastes do not have any useful utilization. Agricultural wastes include wheat husk, rice husk, and their straw, hemp fiber and shells of various dry fruits. These wastes can be used to prepare fiber reinforced polymer composites for commercial use.

1.1 Introduction

A Composite material (also called a composition material or shorten to composite, which is common name) is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined ,produce material with characteristics difference from the individual eg . glass fibre.

A Bio-composite is a composite material from by Matrix resin and reinforcement of natural fibres these kinds of material in wall in a process keeping the strengthening properties of matrix that was used by always providing biocompatibility eg Jute sack.

A Synthetic fibres are textiles made from man-made rather than natural fibers. Examples of synthetic fabrics include polyester, acrylic, nylon, rayon, acetate, spandex, latex, Orlon and Kevlar. A synthetic fabric, when magnified, looks like plastic spun together.

A Natural Fibers are defined as substances produced by plants and animals that can be spun into filament, thread or rope and further be woven, knitted, matted or bound Eg. Cotton, wool, sisal.

1.1.1 Types of composites based on matrix

1. Metal Matrix Composites (MMC)
2. Ceramic Matrix Composites (CMC)
3. Polymer Matrix Composites (PMC)

1. Metal Matrix Composites: Higher strength, fracture toughness and stiffness are offered by metal matrices. Metal matrix can withstand elevated temperature in corrosive environment than polymer composites. titanium, aluminum and magnesium are the popular matrix metals currently in vogue, which are particularly useful for aircraft applications. Because of these attributes metal matrix composites

are under consideration for wide range of applications viz. combustion chamber nozzle (in rocket, space shuttle), housings, tubing, cables, heat exchangers, structural members etc. 2. Ceramic matrix Composites: One of the main objectives in producing ceramic matrix composites is to increase the toughness. Naturally it is hoped and indeed often found that there is a concomitant improvement in strength and stiffness of ceramic matrix composites. 3. Polymer Matrix Composites: Most commonly used matrix materials are polymeric. In general the mechanical properties of polymers are inadequate for many structural purposes. 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 processing of polymer matrix composites need not involve high pressure and doesn't require high temperature. Also equipment required for manufacturing polymer matrix composites are simpler. For this reason polymer matrix composites developed rapidly and soon became popular for structural applications composites based on reinforcement (1) Fibrous Composite: A fiber is characterized by its length being much greater compared to its cross-sectional dimensions. The dimensions of the reinforcement determine its capability 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. Man-made filaments or fibers of non polymeric materials exhibit much higher strength along their length since large flaws, which may be present in the bulk material, are minimized because of the small cross-sectional dimensions of the fiber. In the case of polymeric materials, orientation of the molecular structure is responsible for high strength and stiffness.(2) 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 a limited extent. Particle fillers are widely used to improve the properties of matrix materials such as to modify the thermal and electrical conductivities, improve performance at elevated temperatures, reduce friction, increase wear and abrasion resistance, improve machinability, increase surface hardness and reduce shrinkage. (3) hybrid composite Hybrid composites are more advanced composites as compared to conventional FRP composites. Hybrids can have more than one reinforcing phase and a single matrix phase or single reinforcing phase with multiple matrix phases or multiple reinforcing and multiple matrix phases. They have better flexibility as compared to other fiber reinforced composites. Normally it contains a high modulus fiber with low modulus fiber. The high-modulus fiber provides the stiffness and load bearing qualities, whereas the low-modulus fiber makes the composite more damage tolerant and keeps the material cost low. The mechanical properties of a hybrid composite can be varied by changing volume ratio and stacking sequence of different plies. Special Issue Recent Trends In Mechanical engineering, VVPIET, Solapur, Maharashtra. 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. Natural fibres are plant based which are lignocellulosic in nature and composed of cellulose, hemicelluloses, lignin, pectin and waxy substances. Cellulose gives the strength, stiffness and structural stability of the fibre, and are the major framework components of the fibre. According to the type of fibre, cellulose has its own cell geometry which is responsible for the determination of mechanical properties of plant fibres. Hemicelluloses occur mainly in the primary cell wall and have branched polymers carbon sugars with varied chemical structure. Lignin is amorphous and has an aromatic structure. Pectin structure is complex, their side chains are often crosslinked with the calcium ions and arabinose sugars. The lignin, hemicelluloses and pectin provides the adhesive to hold the cellulose framework structure of the fibre together. Their availability, renewability, low density, and price as well as satisfactory mechanical properties makes 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

paneling, partition boards), packaging, consumer products, etc.

2.1 Literature Survey

Madhukaran J. et al.[1] Tensile strength , impact strength and flexural strength test has been conducted and we come to know that 25 : 15 ratio of composite material gives better results. Author performed several experiments in different composition in 30 : 20 and 10 : 30 but out of them only 25:15 provide better result. v. Felix swamidass et al. [2] The samples with different percentage of pineapple leaf fiber can give better properties. Compressive strength, hardness and wear of different samples were seen to decrease with increase in percentage of pineapple leaf fiber. While the water absorption rate increases with increase in percentage of pineapple leaf fiber. Santosh Kumar et al. [3] material removal rate, taper angle, circularity, runout, surface roughness were observed by varying current pulse on time, pulse off time, dielectric pressure and spark gap voltage. Increase in spark eroding process was experimentally observed. R.Prem Kumar et al. [4] The experiments were carried out to determine tensile, flexural, impact, compression, hardness and water absorption for all four different hybrid composites M. Prabakaran et al. [5] In this research, some interesting facts have been observed and discussed. PCLSP shows some higher result in both tensile and flexural properties. Gabriel Oliveira Glória et al. [6] Selected pineapple leaf fibers (PALF) significantly improve improvement .The strength of polyester matrix composites. This improvement corresponds basically to a linear increase up to 30 vol% of fiber incorporation and surpasses the flexural results with similar composites. N. Siva et al. [7] For extracting PALF we carried out manual extraction process. This resulted in fibers of comparatively lower strength because of reduced wax content. A. Danladi et al. [8] PAF/HDPE composites produce and tested show that useful materials could be produced out of the PAF. The composites have low density values, which is one of the major requirements of composites materials. Subbiah Jeeva.G et al. [9] The fiber reinforced composite material was fabricated and then its mechanical properties like tensile and impact strength was determined. R.M.N. Aribet al. [10] The results of the present study showed that useful composites with good strength could be successfully developed using pineapple fibre as a reinforcing agent for the polypropylene matrix. Tensile modulus and tensile strength of the composites increased significantly, compared with pure resin. Asama Kalapakdee et al. [11] Mechanical properties of uniaxial San-PALF composites were prepared from uniaxial prepreg and studied with respect to PALF content, measurement direction and compression temperature

J.K. Odusote et al. [12] Pineapple fiber reinforced epoxy composites had better flexural, impact and tensile properties than fiber glass and pineapple fiber reinforced polyester composites. Cintia Paula Feitosa Souza et al. [13] In our study, eleven bands were chosen for their highly significant correlation with fiber quality variables. Therefore, after sequencing and validation, many combinations of bands can be used to increase the chances of success of MAS. Kloykamol Panyasart et al. [14] Alkali and silane treatments were conducted to treat the PALF surfacesbefore melt compounding with polyamide 6. Three types of pineapple leaf fiber which were R-PALF, Na-PALF and Si-PALF were used in this study. Effect of fiber treatment on the properties of the PALF/polyamide 6 composites had been investigated. Manpreet Singh Bahra et al. [15] The tensile strength of pineapple/HDPE composite decreases with the increase in pineapple fibre content from 5 to 25%. However, the tensile modulus is observed to decrease with the increase in content of pineapple fibres. The tensile strength and tensile modulus of pineapple/HDPE composite are higher than that observed for HDPE specimen, except lower value of tensile strength noticed for 25% pineapple/HDPE composite.

Yusri Yusof, Nazuandi bin Mat Nawi et al. [16 In this paper, the tensile strength and hardness of pineapple leaf fiber and pineapple peduncle fiber reinforced polypropylene composites was measured. Based on the results, it was found that the tensile strength showed decreased when increasing the fiber volume fractions. L. LEÃO et al. [17] The utilisation of PALFs and their composites has triggered the interest of researchers due to their environmental advantages. Un 6thlike some fi bers, PALFs seldom cause problems at the end-of-product life stage. Nithima Nakthong et al. [18] Pineapple stem is an agricultural waste with high potential as an alternative source of starch. Pineapple stem starch can be extracted simply from pineapple stem by wet-grinding. M. Asim et al [19 The hybridization of treated PALF and KF into PF matrix have improved mechanical strength such as flexural strength and impact strengths and decline tensile strength with increasing PALF loading in comparison of untreated PALF/ KF/PF hybrid composites. . Treated PALF helped hybrid composites to increase flexural strength, modulus, impact strength and energy absorption while KF helped to enhance tensile strength and modulus. FTIR of hybrid composite revealed the chemical changes before and after

treatment of hybrid composites and showed that silane eliminates the lignin and hemicellulose from the fibre's surface. Supranee Kaewpirom et al [20] The emphasis on environmentally sustainable materials and processes has made an increased interest in the development of natural fibers based bio-composites. Consuming, on average, 60 % less energy than the manufacture of glass fibers on their production, being derived from renewable sources and being biodegradable make natural fibers suitable for bio-composites production. L. UMA DEVI et al [21] experimentally analysed that tensile strength ,flexural strength and impact strength is more than the results which are obtain from unidirectional pineapple fiber strength. JAYAMOL GEORGE et al [22] PALF-reinforced LDPE composites were prepared by melt-mixing and solution-mixing methods. Processing characteristics of these composites were studied. Rungsima Chollakup et al. [23] An SEM study on the tensile fractured surface confirmed the homogeneous dispersion of the long fibers in the polymer matrixes better than dispersion of the short fibers. Miriam Mabel Selani et al [24] The pineapple pomace showed low fat and protein content and had dietary fibre as one of its major components (45.22 ± 3.62%), with the insoluble fraction accounting for the majority of the fibre. Kanokwan Yantaboot [25] . Pineapple leaf fiber (PALF) and carbon black contents were fixed at 10 parts (by weight) and 30 parts (by weight) per hundred parts of rubber (phr), respectively. In order to improve the dispersion, PALF with rubber was prepared as a masterbatch. Carbon black was added to the compound either as a single portion or as two separate portions, one in the PALF masterbatch and the other in the main mixing step. A. Razmi et. al. [26] according to author Toughness of about 45% can be achieved by using jute fiber and concrete with respect to the the concreate . Magdi El Messiry et. al. [27] This has been proved that after pulverisation the characteristics improved such as physical and mechanical properties. Vivek Mishra et. al.[28] Improve physical and mechanical behaviour of composite has been observed according to this author. Ajith Gopinath et. al.[29]author has used jute fiber and he observed that jute reinforced epoxy composite exhibited better mechanical properties. M. Ramesh et. al.[30] hand lay-up method with jute fiber 35mm embrace better tensile and flexural properties.

Conclusion

We have studied review on bio composite materials and some of the authors are worked on natural fibers to tried to use natural fibers in substitution of synthetic fibers, as they are having good properties than natural fibers but they consists of some disadvantage that they can not be recycled and made from petroleum products which are non-renewable

References

[1] Madhukiran J. ,Dr. S. Srinivasa Rao, Madhusudan.S," Fabrication And Testing Of Natural Fiber Reinforced Hybrid Composites Banana/Pineapple", International Journal Of Modern Engineering Research (IJMER),3(4),Pp-2239-2243, 2013.

[2] V. Felix Swamidoss, Prasanth," Fabrication And Characterization Of Brake Pad Using Pineapple Leaf Fiber (PALF)", International Journal Of Research In Computer Applications And Robotics,3(3), pp. 107-111, 2015.

[3] Santosh Kumar D S, Praveen B A, Kiran Aithal S, U N Kempaiah," Development Of Pineapple Leaf Fiber Reinforced Epoxy Resin Composites", International Research Journal Of Engineering And Technology (IRJET), 02(03),pp.210-215,S 2015.

[4] R.Prem Kumar, Guddakesh Kumar Chandan, R.Ramamoorthi," Fabrication And Testing Of Natural Fiber Hybrid Composites", International Journal Of Engineering Research,5(4), pp. 285-288, 2016.

[5] M. Prabakaran, Jaiguru Narayanasamy, V. Vignesh , M. Kathiravan," Experimental Analysis Of Mechanical Properties On Hybrid Composite Materials Reinforced With Pineapple Fiber/Coir Leaf Sheath", International Journal Of Mechanical Civil And Control Engineering,1(1), pp.220-230, 2015.

[6] Gabriel Oliveira Glóriaa, Maria Carolina Andrade Teles A, Felipe Perissé Duarte Lopes A, Carlos Maurício Fontes Vieiraa, Frederico Muylaert Margemb, Maycon De Almeida Gomesc, Sergio Neves Monteiro," Tensile Strength Of Polyester Composites Reinforced With PALF",x(x),pp.2523-2530 2010.

[7] N. Siva, J. John Paul," Fabrication And Experimental Analysis Of Pineapple Leaf Fiber Based Composite Material", Journal Of Chemical And Pharmaceutical Sciences,x(x), pp.0974-2115,2015.

[8] A. Danladi, J. Shu'aib," Fabrication And Properties Of Pineapple Fibre / High Density Polyethylene Composites", American Journal Of Materials Science, x(x),pp.263-272, 2014.

[9] Subbiah Jeeva.G, Subin Kumar.M, Yabez Raj.D, " Fabrication And Testing Of Fiber Reinforced Composite Material", International Journal of Innovative Research In Science, Engineering and Technology, 4(6),pp.x(x), May 2015.

[10] R.M.N. Arib , S.M. Sapuan , M.M.H.M. Ahmad , M.T. Paridah , H.M.D. Khairul Zaman, "Mechanical Properties Of Pineapple Leaf Fibre Reinforced Polypropylene Composites", Materials And Design 2(7),pp. 391–396, 2006

[11] Asama Kalapakdee, Taweechai Amornsakchai," Mechanical Properties Of Preferentially Aligned Short Pineapple Leaf Fiber Reinforced Thermoplastic Elastomer: Effects Of Fiber Content And Matrix Orientation", Journal Homepage: Polymer Testing ,37pp: 36–44, 2014.

[12] J.K. Odusote1, A.T. Oyewo," Mechanical Properties Of Pineapple Leaf Fiber Reinforced Polymer Composites For Application As A Prosthetic Socket", Journal Of Engineering And Technology,

[13] Cintia Paula Feitosa Souzaa , Claudia Fortes Ferreira, Everton Hilo De Souzaa , Alfredo Rodrigues Sena Neto , José Manoel Marconcini , Carlos Alberto Da Silva Ledo , Fernanda Vidigal Duarte Souza," Genetic Diversity And Issr Marker Association With The Quality Of Pineapple Fiber For Use In Industry", Industrial Crops & Products,104, pp: 263–268, 2017.

[14] Kloykamol Panyasarta, Nattawut Chaiyuta, Taweechai Amornsakchaib, Onuma Santawitee," Effect Of Surface Treatment On The Properties Of Pineapple Leaf Fibers Reinforced Polyamide 6 Composites", Energy Procedia ,56 pp:406 – 413, 2014.

[15] Manpreet Singh Bahra, V.K. Gupta, Lakshya Aggarwal," Effect Of Fibre Content On Mechanical Properties And Water Absorption Behaviour Of Pineapple/HDPE Composite ",Materials Today,4, pp. 3207–3214 ,2017.

[16] Yusri Yusof, Nazuandi Bin Mat Nawi And Muhammad Shazni Hilmi Bin Alias " Pineapple Leaf Fiber And Pineapple Peduncle Fiber Analyzing And Characterization For Yarn Production ",11(1-2), Pp. 4197-4202, 2016.

[17] A L. Leão, M. Cherian And S. Narine, S. F. Souza And M. S Ain, S. Thomas," The Use Of Pineapple Leaf Fi Bers (PALFs) As Reinforcements In Composites", Bio-fiber Reinforcement In Composite Materials,chapter 7, pp.212-234,2015.

[18] Nithima Nakthonga, Rungtiwa Wongsagonsup, Taweechai Amornsakchai, " Characteristics And Potential Utilizations Of Starch From Pineapple Stem Waste", Industrial Crops & Products, industrial Crops & Products, 105, pp.74–82, 2017.

[19] M. Asim, M. Jawaid, K. Abdan,m. R. Ishak," Effect Of Pineapple Leaf Fibre And Kenaf Fibre Treatment On Mechanical Performance Of Phenolic Hybrid Composites," Fibers And Polymers ,18, pp. 940-947, 2017.

[20] Supranee Kaewpirom, Cherdthawat Worrarat," Preparation And Properties Of Pineapple Leaf Fiber Reinforced Poly (lactic Acid) Green Composites," Fibers And Polymers,15, pp. 1469-1477, 2014.

[21] L. Uma Devi, S. S. Bhagawan, Sabu Thomas," Mechanical Properties Of Pineapple Leaf Fiber-reinforced Polyester Composites", Devi, Bhagawan, And Thomas,x(x) pp. 1739-1754,1996.

[22] R.Bianchi ,"Treatment And Reuse Of Wastewater From Textile Wet Processing Industry", Journal Of Chemical Technology,72, pp. 289-302,1998.

[23] Rungsima Chollakup, Rattana Tantatherdtam, Suchada Ujjin, Klanarong Sriroth, "Pineapple Leaf Fiber Reinforced Thermoplastic composites: Effects Of Fiber Length And Fiber Content On Their Characteristics", Journal Of Applied Polymer Science,x(x), pp. 1953-1963, 2010.

[24] Miriam Mabel Selani,"Characterisation And Potential Application Of Pineapple Pomace In An Product For Fibre Enhancement", Food Chemistry,163 ,pp. 23–30, 2014.

[25] Kanokwan Yantaboot, Taweechai Amornsakchai," Effect Of Preparation Methods And Carbon Black Distribution On Mechanical Properties Of Short Pineapple Leaf Fiber-carbon Black Reinforced Natural Rubber Hybrid Composites", Material Properties, 61, pp.223-228, 2017.

[26]A. Razmi, M.M. Mirsayar," On The Mixed Mode Fracture Properties of Jute Fiber Reinforced Concreate", Constuction and Building Materials,148, pp.512-520,2017.

[27] Magdi El Messiry, Shaimaa El-Tarfawy, Rania El Deeb," Study Pultruded Jute Fabric Effect On The Cementitious Thin Composites Mechanical Properties With Low Fiber Volume Fraction",alexandria Engineering Journal, xxx, Pp. Xxx-xxx, 2017.

[28] Vivek Mishra ,Sandhyarani Biswas," Physical And Mechanical Properties Of Bi-Directional Jute Fiber Epoxy Composites", SciVerse Sciencedirect,51(x), pp.561-566, 2012.

[29] Ajith Gopinath, Senthil Kumar., M Elayaperumal A.," Experimental Investigations On Mechanical Properties Of Jute Fiber Reinforced Composites With Polyester And Epoxy Resin Matrices",GCMM, 97(x), pp.2052-2063, 2014.

[30] M.Ramesh, K Palanikumar, K. Hemachandra Reddy," Comparative Evaluation On Properties Of Hybrid Glass Fiber-Jute Reinforced Epoxy Composites", SciVerse Sciencedirect, Vol.51(x), pp.745-750,2012.