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Experimental investigations on mechanical properties of coconut SPATHE fiber reinforced composites with epoxy and polyester matrices

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Abstract-Bio composite is a composite material formed by a matrix (resin) and a reinforcement of natural fibers like Jute, Coir, Sisal, Pineapple, Ramie, wicker, Banana and Coconut spathe, etc. Such natural fibers composites are low-cost fibers with high specific property, low density and green. Bio composites are classified into wood fibers such as soft and hard woods and non-wood fibers such as straws, jute, sisal etc. It can be used alone, or labeled with standard materials. Thousands of tons of coconut spathe is naturally generated but most of their wastes do not have any useful utilization. This work discusses the implementation of coconut spathe fiber reinforced polymer composite, processing methods and its applications.

Keywords-Bio composites, Polymer Matrix, Natural fibers, Coconut spathe fibers.

I.INTRODUCTION

In recent years, bio composites materials are derived from natural and renewable sources and natural fibers have less environmental impact than glass fiber due to reduced CO_2 emissions and energy consumption during production. In many case bio-based materials offer weight reduction, added functionality and occupational health benefits. Sources of information include technical papers, articles, online information and discussion with experts. The term “bio composites” is used here to denote fiber-reinforced polymer composite materials where the fibers and/or matrix are bio-based. Natural fibers can be described as composites which are naturally occurring consisting mainly of cellulose fibrils fixed in lignin matrix. Along the length of the fiber the cellulose fibrils are aligned, which render

higher tensile and flexural strength. The reinforcing efficiency of natural fiber is corresponding to the cellulose with its crystalline. The usage of polymer based composite material is increasing because of their light weight, good mechanical and tri biological responses. However, composites encounter problems such as fiber crack. Fiber crack and matrix cracking plays an important role in laminates under tensile load.

II. LITERATURE REVIEW

[1]Girisha.C et al, For all the composites tested the tensile strength of the composite increased for approximately 25% of weight fraction of the fibers. The values decrease further for the increase in the weight fraction.

[2]Mulinari, D.R et al, Fatigue behaviour in composites presented a decrease in fatigue life when was applied greater tension. It was observed some failure mechanism as fractured fibers and presence of pull out and poor bonding interfacial between fiber and matrix.

[3]S.M. Sapuan et al, fiber treatment may enhance the interfacial bonding amongst fiber and matrix

loading to better mechanical properties of spathe fiber reinforced composite covers.

[4]Suresh j s et al, Fiber utilized for composite materials were glass fiber, cotton fiber with high quality in damp condition yet corrupt under lifted temperature.

[5]Urmilkumar Chaudhari et al, A fiber is characterized by its length being much greater as compared to its cross-sectional dimensions. Strength and stiffness of natural fibers are generally lower than glass fiber, although stiffnesses can be achieved with natural fiber comparable to those achieved with glass fiber.

Polymer Matrix Composites

Due to its low cost and simple fabrication method of PMC is famous in nature. PMC are characterized by High tensile strength, High fracture toughen, High stiffness, better moisture resistance, better abrasion resistance, Good corrosion resistance & Low cost. PMC combine a resin system and reinforcing fibers, the properties of the resulting composite material will combine something of the properties of the resin on its own with that of the fibers on their own.

Reinforcement

The term “reinforcement” refers to an enhancement of mechanical behavior of composites. The fibers are playing important role in composites because of its various properties. For most of the applications, the fibers need to be arranged into some form of sheet, known as a fabric, to make handling possible. The distribution of fibers also plays a major role in the mechanical properties of unidirectional composites. Two stiffness distribution factors and two strength distribution factors are identified to completely characterize this influence.

Fiber source

Fiber is a class of hair-like structured material that are in separately elongated pieces or are continuous filaments, like pieces of thread. They can be blend into filaments, thread, or rope. They are used as a component of composites materials. They can also be bonded into sheets to make products such as paper or felt. The plants which produce natural fibers are grouped as primary and secondary depending on their utilization. Primary plants are those which have been grown for their fiber particles while secondary plants are plants in which the fibers are extracted as a by-product. The primary plant fibers are Jute, hemp and sisals. Pineapple, Coconut spathe, oil palm and coir are examples of secondary plant fibers.

Coconut spathe

Many natural fibers have been identified which have some appropriate mechanical properties for structural purposes, being of low density, and high specific strength and stiffness. Coconut-spathe fibers are examples of such fibers. Coconut spathe composites have considerable potential to replace conventional materials like metal, plastics and wood in structural and non-structural applications, due to good adhesiveness and mechanical properties. The coconut spathe fibers additionally show numerous intriguing properties like the nearness of a waxy layer that added to the holding of strands with the network material. The waxy layer contained greasy aliphatic mixes which went about as adhesive promoters. Both the fibers were surface treated, chopped and then dispersed thoroughly in the matrix material. The research had been done due to big potential opportunities of coconut spathe fiber. Coconut spathe is the fibrous residue which is left over after the chopping of soaked coconut spathe with having moisture content and consisting of a mixture of hard soft fiber and smooth parenchymatous tissue with maximum hygroscopic property. The chopped coconut spathe is mainly used in construction of temporary shelter. The CO_2 emissions resulting from many industries are equal to the amount of CO_2 that can be absorbed by the plant during its growing phase, which makes the suitable process of cogeneration greenhouse gas-neutral. They create an opportunity in fabrication of coconut spathe based composites towards a broad range of applications in construction such automotive sector, marine and etc. It would also ensure international market for cheaper and better substitution. Natural fibers have the advantages of low density, relative cheapness and biodegradable.

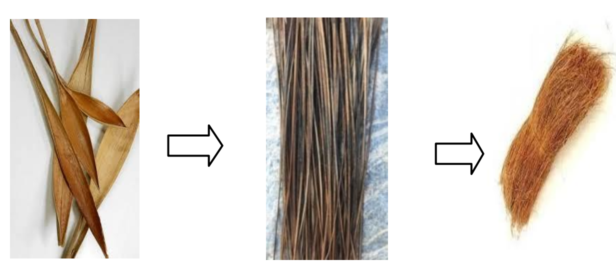

Fig. 1 Coconut spathe Fiber from Coconut spathe

Epoxy Resin

The epoxy have widely adapted for many uses beyond fiber reinforced polymer composites. Epoxy resins are low molecular weight pre-polymers having at least two epoxies groups. The epoxy resins have two types namely glycidyl epoxy and non-glycidyl epoxy resin. To convert epoxy resins into a hard, infusible and rigid, it is necessary to cure with hardener. Epoxy resins have broad range of curing agent and those are depending on properties and process required. High purity substance can be produced for some applications, e.g. using a distillation purification process. Epoxies are created through reacting an epoxy resin and a hardener by reacting the resins themselves. The equivalent weight or epoxies number is used to determine the amount of co-reactant (hardener) to apply when curing epoxy resins. Epoxies are typically cured with stoichiometric to achieve maximum physical properties. There are hundreds of hardener to change epoxy resin properties to acquire most varied requirements. The hardening process consists of an exothermic reaction achieved by having the epoxy resins to react with themselves or through cross-linking with hardener.

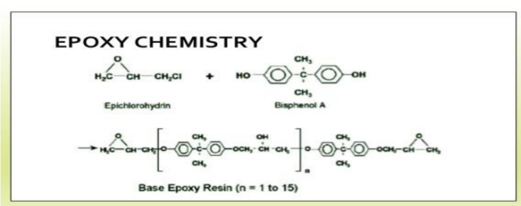

Fig.2 Chemical structure of epoxy resin

The material is cross-linked substances and contains more OH groups, which provide adhesive properties between them. The hardener is completely reacted with epoxies groups and not present anymore. The epoxy based material have broad range of application. Epoxy is a chemical known for its versatile nature. Epoxies are used as engineering adhesives used in construction of aircrafts, automobiles and other some applications. Generally, epoxies are used for better adhesiveness, chemical and electrical resistant. Many properties of epoxies can be modified (for example silver-filled epoxies having good electrical conductivity are available, while epoxies are usually electrically insulated). Variations producing high thermal insulation, or thermal conductivity combine with high electrical resistance for electronics applications, are available.

Polyester resin

Polyester tars are unsaturated manufactured gums framed by the response between dibasic natural acids and polyhydric alcohols. The crude material of polyester gum is Malefic Anhydride with di corrosive usefulness. Polyester saps improve great mechanical, electrical and warm properties with better compound protection and dimensional protection. Polyesters are created with higher volume which surpasses 30 billion pounds in around the world. Divider boards which are created from polyester saps strengthened with fiberglass called fiberglass fortified plastic (FRP) are ordinarily utilized as a part of eateries, kitchen stores, restrooms and different zones that require low-support dividers. Unsaturated polyesters are the buildup polymers created by the response of polios (otherwise called polyhydric alcohols), natural mixes with numerous liquor or hydroxyl useful gathering by soaked or unsaturated dibasic acids. Run of the mill polyesters are utilized as glycols, for example, ethylene glycol acids utilized are ophthalmic and malefic. Water is constantly expelled, and driving the response to culmination. The utilization of unsaturated polyesters and added substances, for example, styrene lessens the thickness of the pitch.

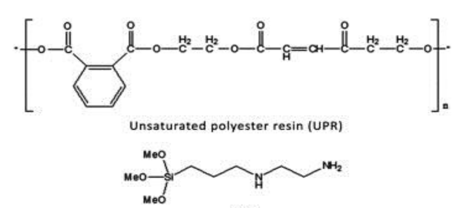

Fig.3 Chemical structure of polyester resin

Preparation of Bio composite

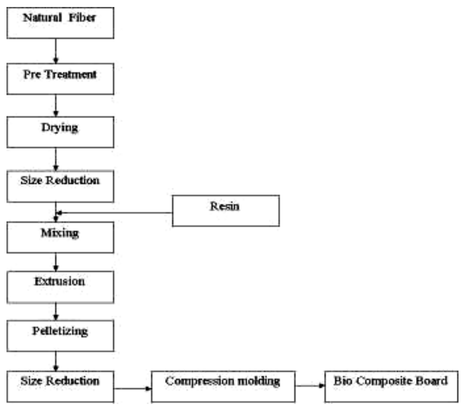

Fig.4 Preparation of Bio composite

Experimental Procedure

The Coconut spathe fibers were chemically treated with NaOH solution. The Coconut spathe fiber was immersed in NaOH solution for 24 hours and then take it out and dried it in a sunlight. The synthesis of Coconut spathe-epoxy and Coconut spathe- polyester composite with relevant weight in grams. .The hardener used for epoxy resin is triethylene tetramine (TETA) and for the polyester is methyl ethyl ketone peroxide (MEKPO). The required fibers were added to the resin mixed hardener with required weight percentages. The fiber resin hardener mixture was poured into moulds for taking different testing prepared as per ASTM standards. The setting for the composites was approximately for 24 hours. Then the prepared composites were subjected to tensile and hardness tests. Hardness was measured using Rockwell hardness tester as per ASTM D785 standard. The synthesis of composites includes two composites of Coconut spathe with polyester and epoxy resins, and the characterization includes the testing of the composites.

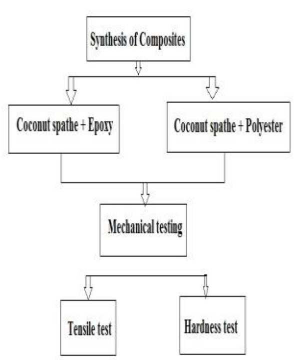

Fig.5 Synthesis of Coconut spathe fiber reinforced composites

Tensile test

The tensile test specimen is prepared according to the ASTM D3039 standards. Figure shows Universal Testing Machine on which the tensile and three point bending tests were carried out on the composites the tensile test was measured from the universal testing machine. The specimen was held on the machine and tensile force was applied. The force Vs displacement graphs are plotted according to the noted displacement. Tensile tests were conducted in a Universal Testing Machine. The specimen dimensions were (ISO 14125): 200 mm × 30 mm × 5 mm.

Hardness Test

The hardness of the composites was estimated utilizing a HPE Shore-A Hardness Tester (demonstrate 60578, Germany) as per ASTM D785-98 amalgamation of composites. Rockwell Hardness test was carried out in our specimen. The specimen dimensions were : 50mm × 50mm × 5mm.

III.RESULT

Resin	Tensile test kN/mm^2	Hardness test RHN	
		Top	**Bottom**
Polyester resin	**0.084**	**84**	**64.75**
Epoxy resin	**0.095**	**86.5**	**67.25**

IV.CONCLUSION

The coconut-spathe epoxy and coconut-spathe polyester composite specimens prepared as per ASTM standards subjected to mechanical characterization results were analysed and compared. This fabrication is made up of simple hand lay up process. This experimentation exhibits better mechanical strengths in coconut spathe epoxy resin matrices than coconut spathe polyester resin matrices. The present review reports the use of coconut spathe fibers, as polymer matrix reinforcements. This review focused at providing knowledge to enhance further research in this area. Characteristic texture composites are for the most part less quality execution contrasted with composites of cross breed materials. Moreover, they can be used in low load condition in automotive sector, marine and etc and also they have the advantages of flexibility in design, low cost, lack of health-hazard problems and having great strength in weight ratio. Hybrid formation of some amounts of synthetic fibers makes these natural fabric composites more suitable for technical applications as in automotive interior parts.

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