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Potential of Coconut SPATHE in Composites: A Review

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Abstract- **The increase in environmental problems due to pollution and non-biodegradable resources has lead to serious health hazards. This has lead to an increase in the demand for the natural composites. But the natural composites in their non-hybridized form normally exhibit lower mechanical properties. Therefore, natural fiber composites are mostly fabricated in hybridized form with other natural or synthetic fibers to enhance their mechanical, chemical & thermal properties& to make them suitable for engineering applications. This paper gives a review on the mechanical properties of coconut spathe fiber. Coconut spathe fiber is naturally available, low cost, less weight, eco-friendly, biodegradable and available in sheet form by nature. This natural fiber is so far not much investigated as their mechanical strength is quite low (1.15 MPa - 2.33 MPa) when used in non-hybridized form. But when it is used in hybridized form it exhibits a good strength & thereby reducing the cost of fabrication.**

Index Terms- **Coconut Spathe, Tensile Strength, Flexural Strength.**

I. INTRODUCTION

The mechanical, physical, thermal & microstructure properties of coconut spathe fiber were investigated by hybridizing it with natural fibers like Sisal, ridge gourd&Kenaf. Chemical treatments were also done to find the increase in their strength properties. The percentage composition also plays a role on the strength of the composite, andalso number of layers and arrangement of different fibers in different forms also determines the strength of the composites.

II. NATURAL FIBER COMPOSITES

Over the past few decades, there has been a growing interest in the use of natural fibers in composite applications. Natural fiber composites have many advantages compared to synthetic fibers, such as low density, low tool wear, cheaper cost, ease of availability, and biodegradability. The most common natural plant used in applications are banana, jute, flax, kenaf, and sisal. One of the reasons for this growing interest is that natural fibers have a higher specific strength than glass fiber. With these properties and cheaper sources, these natural fibers theoretically offer desirable specific strengths, at a lower cost.Many naturally occurring fibers can be used as composites, but mostly in applications that involve low stress. Some of the fibers are obtained by processing agricultural, industrial, or consumer waste.

III. PROPERTIES OF SPATHE FIBER

Mechanical Properties when chemical treated [1]: ABDUL HAKIM Abdullah, FARIS FIRDAUS Abdul Mutalib, MUHD FAIZ Mat studied from their paper "Tensile and Fracture Toughness Properties of Coconut Spathe Fiber Reinforced Epoxy Composites: Effect of Chemical Treatments" that the serious problem of natural fibers is their strong polar character which creates incompatibility with most polymer matrices. In present investigation, the effect of alkaline, silane and combination of both treatment is investigated. Tensile properties and fracture toughness of coconut spathe fiber for untreated and treated were evaluated. Result indicated that silane treatment has achieved a better performance for the tensile test while there is no improvement fracture toughness displayed by silane or alkaline treatment as compared to untreated fibers. The alkaline treatment showed to be harmful for fracture toughness of the coconut spathe fiber since the improved interfacial adhesion impaired the main energy absorption mechanisms. The result indicates the alkaline treatment is harmful while the silane treatments are possibly the alternative treatment in improving mechanical properties on coconut spathe composites.

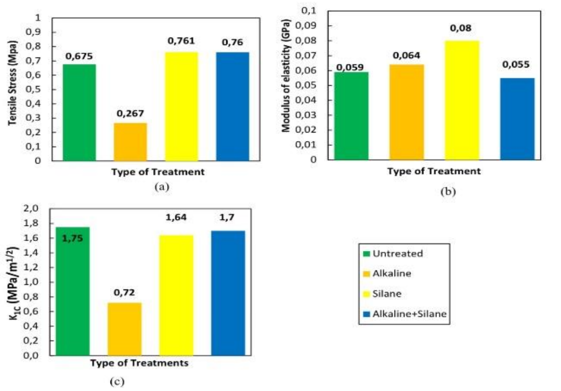

Figure 1: Effect of Chemical Treatment on (a) Tensile Stress, (b) Modulus of elasticity and (c) Stress intensity Factor

Tensile Property: Figure 1 (a) shows that the highest tensile stress at maximum load is from silanesolution treatment with 0.761 MPa followed by 0.760 MPa for alkaline+silane treatment, 0.675MPa for untreated and the least one is 0.267 MPa for alkaline treatment.

Modulus of elasticity: Figure 1 (b) shows the graph of average modulus of elasticity against the different types of treatment on coconut spathe fiber reinforce composite. The silane treated coconut spathefiber composite produced the highest value of modulus elasticity which is 0.08GPa followed by alkaline treatment, untreated and alkaline+silane.

Fracture Toughness: Figure1 (c) showed the graph of critical intensity stress factor k1c for untreated and the different types of treatment used. The toughness for untreated specimen showed the highest value on k1c of 1.75 MPa.m½ followed by alkaline+silane treatment with 1.70MPa.m½, silane treatment with 1.64 MPa.m½ while the specimen for alkaline treatment gives the lowest values of k1c with the value of stress intensity factor of 0.72 MPa.m½.

Tensile Properties When Hybridized withSisal & Ridge Guard [2]: S. Hemalatha, N. Ramesha from their paper "Tensile Properties of Natural Fiber-Reinforced Epoxy-Hybrid Composites" showed about the study been carried out to investigate the tensile properties of composites made by reinforcing sisal, coconut spathe and ridge gourd as the new natural fibers into epoxy resin matrix. The natural fibers extracted by retting and manual processes were subjected to alkali treatment. The composites fabricated consist of reinforcement in the hybrid combination like sisal-spathe, sisal-ridge gourd and spathe-ridge gourd with the weight fraction of fibers varying from 5% to 30%. It has been observed that the tensile properties increase with the increase in the weight fraction of fibers to certain extent and then decreases. Tensile Strength of Epoxy-Sisal-Spathe-Hybrid Composite; there is a considerable increase of tensile strength as the percentage of fiber increases to a maximum of 25% and then the strength decreases. The maximum Tensile strength of 59MPa is obtained for 25% fiber reinforcement, there by 54 % increase in the tensile strength compared with pure Epoxy. The individual reinforcements like Sisal, Ridge gourd and Coconut spathe have a maximum tensile strength of 53 MPa, 46 MPa and 56 MPa respectively. The hybridization of these natural fibers has provided considerable improvement of tensile strength when compared to individual reinforcement.

Tensile Strength of Epoxy-Sisal-Coconut Spathe-Hybrid- Composite]: Figure 2 shows the combination of fibers used is Sisal and Coconut Spathe. In these composites there is a considerable increase of tensile strength as the percentage of fiber increases to a maximum of 25% and then the strength decreases. The maximum Tensile strength of 59 MPa is obtained for 25% fiber reinforcement, there by 54 % increase in the tensile strength compared with pure Epoxy.

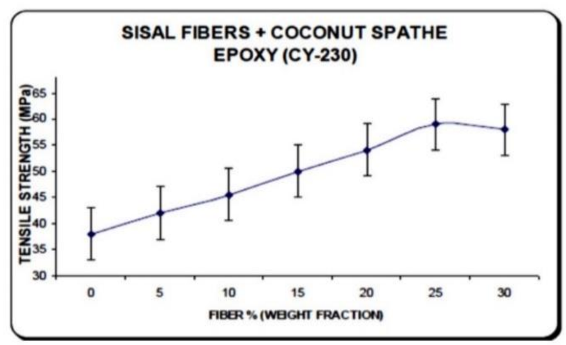

Figure 2: Tensile Strength of Epoxy-Sisal-Coconut spathe-Hybrid-Composite

Tensile Strength of Epoxy-Coconut Spathe - Ridge Gourd-Hybrid-Composite: Figure 2 is the combination of fibers used is Ridge gourd and Coconut Spathe. In these composites there is a considerable increase of tensile strength as the percentage of fiber increases to a maximum of 25% and then the strength decreases. The maximum Tensile strength of 58 MPa is obtained for 25% fiber reinforcement. This combination gives the lowest tensile strength among the hybrid combinations.

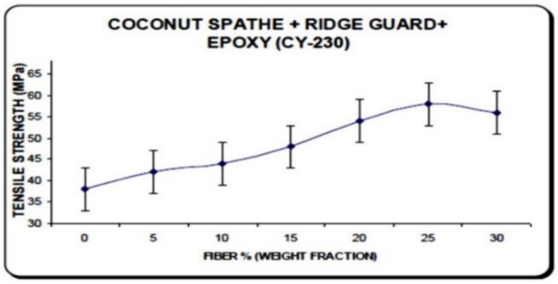

Figure 3: Tensile Strength of Epoxy-Coconut Spathe-Ridge Gourd-Hybrid-Composite

Tensile strengths of the composites with EPOXY-CY-230 as Matrix: Figure 3 shows the variation of tensile strength of all the combination of fibers used. The individual reinforcements like Sisal, Ridge gourd and Coconut spathe have a maximum tensile strength of 53 MPa, 46 MPa and 56 MPa respectively. The variation of tensile strength with respect to the percentage of fiber shows that beyond 25% of fiber the tensile strength decreases. The reason is 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 will not take place and leads to failure quickly.

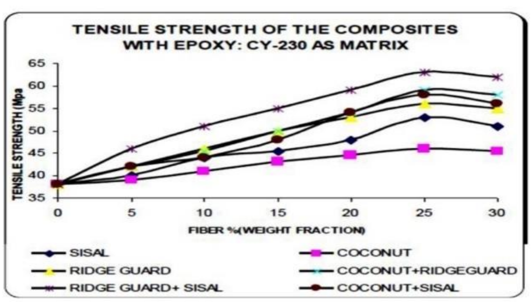

Figure 4: Tensile Strengths of the composites with Epoxy-CY-230 as Matrix

Tensile and flexural strengths of coconut spathe-fiber reinforced epoxy composites [3]: S.M. Sapuan, M.N.M. Zan, E.S. Zainudin and Prithvi Raj Arora studied from their paper "Tensile and flexural strengths of coconut spathe-fiber reinforced epoxy composites"; Tensile and flexural strengths of coconut spathe and spathe-fiber reinforced epoxy composites were evaluated to assess the possibility of using it as a new material in engineering applications. Samples were fabricated by the hand lay-up process (30:70 fiber and matrix ratio by weight) and the properties evaluated using the INSTRON Material Test System.

Tensile and Flexural Test: The highest maximum stress of spathe was 2.33 MPa, while the lowest maximum stress was 1.15 MPa. Tensile and flexural strengths for the coconut spathe-fiber-reinforced composite laminates ranged from 7.9 to 11.6 MPa and from 25.6 to 67.2 MPa respectively, implying that the tensile strength of coconut spathe-fiber is inferior to other natural fibers such as cotton, coconut coir and banana fibers.

However, fiber treatment may improve the interfacial bonding between fiber and matrix leading to better mechanical properties of the spathe-fiber-reinforced composite laminates.

Micro structured Coconut Spathe Fiberas Biofilter Mediafor Air Pollution Control [4]: Rizelin John G. Ofelia, Noel Xavier B. Fuentes, Glenn Rafael A. Huan studied from their paper "Microstructured coconut spathe fibers as biofilter media for air pollution control"; In this study, the feasibility of using coconut spathe fibers as fibrous air filter media was investigated. The main objective of this work was to determine if the coconut spathe fibers are also effective as filtering media to control air pollution. Specifically, it also aims: (i) to determine and compare the level of pollutants in terms of light absorption coefficient (κ) with and without the spathe-based filtering media, (ii) to measure and compare the level ofpollutants in terms of light absorption coefficient (κ) as a function of spathe-based filtering media layers. The potential of coconut spathe fibers (CSF) as bio filter against air pollution emitted by diesel engine was successfully tested.

Results suggest that using CSF-based air filter media can substantially and rapidly reduce the amount of suspended particulate matters and other hazardous gaseous pollutants in the exhausted smoke. In addition, the smoke became cleaner and transparent as CSF increases from single tothree layers.

Study of Mechanical, Physical & Thermal Propertiesof Coconut Spathe Fiber Reinforced Unsaturated Polyester Composite [5]: S. A. Dhar, D. Roy, M. A. Gafur and M. S. Khatun studied from their paper "Study of the mechanical, physical and thermal properties of coconut spathe fiber reinforced unsaturated polyester composite"; this research work has been initiated to study the mechanical and physical properties of coconut spathe reinforced unsaturated polyester composite. Effect of different fiber weight addition with unsaturated polyester resin have been studied. The increase in fiber content leads to improved tensile properties up to some extent. Tensile strength of the composites increases with addition of fiber content up to 35 wt % of fiber exhibiting the highest tensile stress of 27.9 MPa for 40 wt% fiber contents of the composite. The incorporation of further fiber content results in a decrease in tensile strength. However, the addition of 50 wt% of fiber dramatically decreases the tensile strength of the composite. Density of the composites decreases with fiber addition.

So, considering mechanical properties, better thermal stability and moderate water absorption behavior as the quality important parameters this study suggests to select 40:60 (fiber: matrix) composite for the best properties.

CONCLUSIONS

Thus, Coconut spathe fibers can be effectively used as an alternative to replace synthetic fibers. Coconut spathe is easily available at considerably negligible price.Though when these fibers are used alone gives comparatively lower strength, it can be hybridized with other fibers like Sisal, Ridge Gourd, Jute, Banana etc. which can give very good strength. This can reduce the cost of material.

- The Tensile strength of Coconut Spathe fiber ranges from 0.675 to 2.33 MPa.
- Tensile and flexural strengths for the coconut spathe-fiber-reinforced epoxy composite laminates ranged from 7.9 to 11.6 MPa and from 25.6 to 67.2 MPa respectively.
- The silane treated Coconut Spathe fiber composite produced the highest value of modulus elasticity which is 0.08GPa.
- The fracture toughness for untreated coconut spathe fiber showed the highest value on k1c (stress intensity factor) of 1.75 MPa.m½.
- The Tensile strength of 59 MPa is obtained when coconut spathe fiber was hybridized with Epoxy-Sisal fiber.
- The Tensile strength of 58 MPa is obtained when coconut spathe fiber was hybridized with Epoxy-Ridge Gourd fiber.
- Using Coconut Spathe fiber-based air filter media can substantially and rapidly reduce the amount of suspended particulate matters and other hazardous gaseous pollutants in the exhaust smoke.

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