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Mechanical Behavior of Areca Nut and Glass Fiber Reinforced Hybrid Composites

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Abstract: **Areca nut fibers and Areca nut fiber with Glass fibers are reinforced with epoxy matrix and composites have been developed by hand lay-up technique. The effect of areca nut and Glass fibers on mechanical properties of epoxy composites was studied. The mechanical properties include tensile and flexural properties as per ASTM standard Procedures. The analysis continued to evolve a comparative study of pure Areca nut fiber and hybrid Areca nut & Glass composites. The results revealed that incorporation of glass fiber in Areca nut fiber improved the mechanical properties of the composite in a greater extent.**

Keywords: **Areca nut, Characterization, Properties, Addition, Procedures.**

I. INTRODUCTION

A composite material can be defined as a combination of two or more materials that results in better properties than those of the individual components used alone. The two materials work together to give unique properties. The main objective of composite materials are their high strength and stiffness, combined with low density, when compared with bulk materials, allowing for a weight reduction in the finished part [1].Natural polymers like jute, areca nut, pineapple, flax, wood etc. are biodegradable and easily decomposable in the environment [2]. To keep the environment free from pollution, the use of biodegradable and environmental friendly polymer is important and hence scientists all over the world are becoming interested in natural polymer.

Natural fibers turn to superior alternative of synthetic fibers as reinforcements for polymeric composites due to their high flexural modulus and impact strength. In addition, natural fibers are environment friendly, biodegradable, abundantly available, renewable with low density and cheap. Pineapple leaf, oil palm fiber, hemp, sisal, Jute, areca nut, kapok, rice husk, bamboo, and wood are some of the natural fibers most commonly used as reinforcement materials in polymer composites. Among all the plant fibers, areca nut fiber appears to be the most useful and less expensive fiber. The mechanical properties of a natural fiber polymer matrix composite are controlled mainly by the efficiency of the bonding at the fiber-matrix interfacial boundary [3]. The principal function of the interface is to facilitate the transfer of stress from fiber to fiber, across the matrix.

The poor mechanical properties of natural fiber composites sometimes restricted its application in advanced area like automotive, construction, civil engineering etc. Hybridization could be a wonderful solution to these problems. Hybridization offers a wide range of tailor abilities to the composite materials. Hybrid composites are defined as the reinforcing of more than one fiber in the matrix system. They provide some unique properties which cannot be obtained by monolithic composites [4].

II. MATERIALS AND METHODS

In this work, tests have been conducted for Areca nut fiber composite material as well as its hybridization with glass. These composites are prepared using epoxy resin and hardener. The pivotal idea of analyzing Areca nut fiber composite and Areca nut fiber & Glass hybrid composite was with a notion to increase the mechanical properties. Two different types of composite samples were fabricated using hand layup method.

III. PARAMETERS OF MATERIAL TESTING

After fabrication, the test specimens were subjected to various mechanical tests as per ASTM standards. Tensile tests were conducted according to ASTM D 638-01 and Flexural tests were conducted according to ASTM D 7264 using a Universal Testing Machine with a cross-head speed of 10 mm/min. To obtain a statistically significant result for each condition, three specimens were tested to evaluate the mechanical properties.

IV. RESULT AND DISCUSSION

TENSILE STRENGTH:

When force has been applied during tensile testing of composite materials, the samples have tended to break and before breakage it elongated to the breaking point. Tensile strength, young's modulus, elongation at break of the fabricated samples were determined. Tensile strength of Areca nut fiber & Epoxy composite and Areca nut fiber & Glass hybrid composite specimens are presented in the Fig. 4.1. The maximum tensile strength recorded for hybrid composite sample was found to be 246 MPa. The Areca nut fiber & Epoxy composite shows tensile strength of 17.27 MPa which is lower than the hybrid composite. This can be attributed to the lower tenacity of areca nut fiber compared to the glass. In addition the bundle forms of glass fiber may play the crucial role in determining the tensile strength of composite samples. It is evident from the figure that, hybridization of glass fiber with areca nut fiber increased the tensile strength dramatically. All composites are failed in brittle manner the fractured specimens are shown in Fig.4.2.

Fig.4.1: Tensile Fractured specimens of Areca nut fiber and Areca nut fiber & Glass hybrid composite

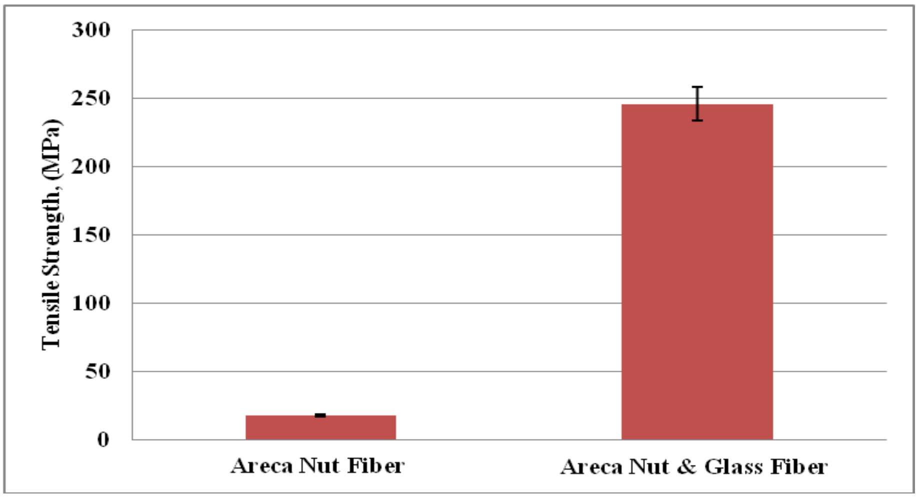

Fig.4.2: Comparison of tensile strength of Areca nut fiber and Areca nut fiber & Glass hybrid composite

YOUNG'S MODULUS:

Young's modulus of Areca nut fiber and hybrid composite is illustrated in the Fig. 4.3. It is observed that young's modulus of the tested specimens shows the similar pattern like tensile strength. Areca nut fiber & Epoxy composite specimen shows the lowest tensile modulus of 760.123 MPa. On the other hand young's modulus increased by 430.65% and reaches the topmost point after hybridization of glass fiber within Areca nut fiber & Epoxy composite. This may be due to the higher strength and stiffness of glass fiber. Similar effect was reported by the researchers Wambuaet.al [5].

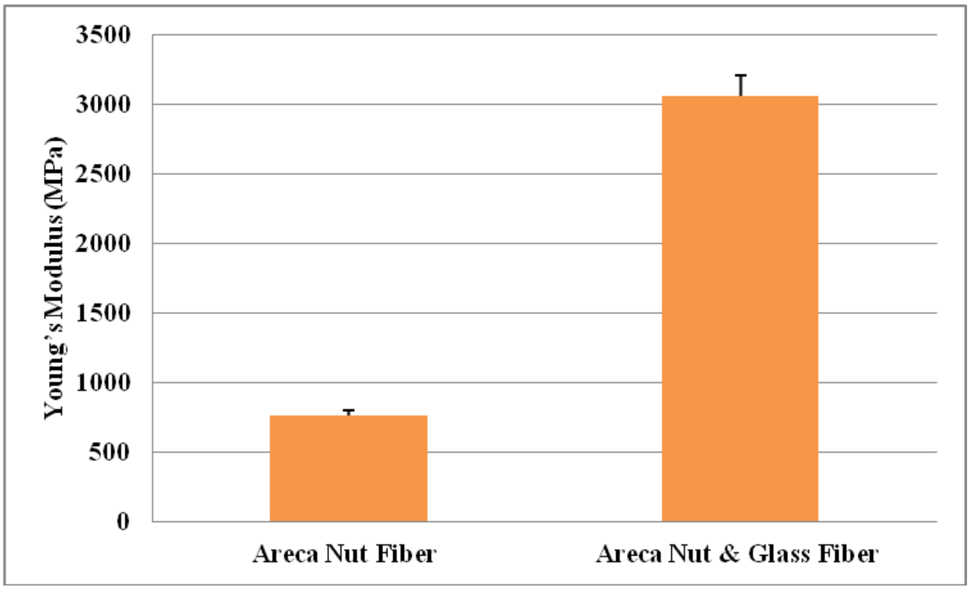

Fig.4.3: Comparison of young's modulus of Areca nut fiber and Areca nut fiber & Glass hybrid composite

ELONGATION AT BREAK:

The failure force for Areca nut fiber & Epoxy composite and hybrid composite samples are demonstrated in the Fig. 4.4. It is apparent in the Figure that hybrid composite undergoes greater extension compared to Areca nut fiber & Epoxy composite. The extension of hybrid composite before failure is found to be 5.208 % whereas Areca nut fiber & Epoxy composite shows decrease in the extension percentage. These results can be substantiated from the research of Wambua et al [5]. They showed that glass fiber has greater extensibility than the areca nut fibers.

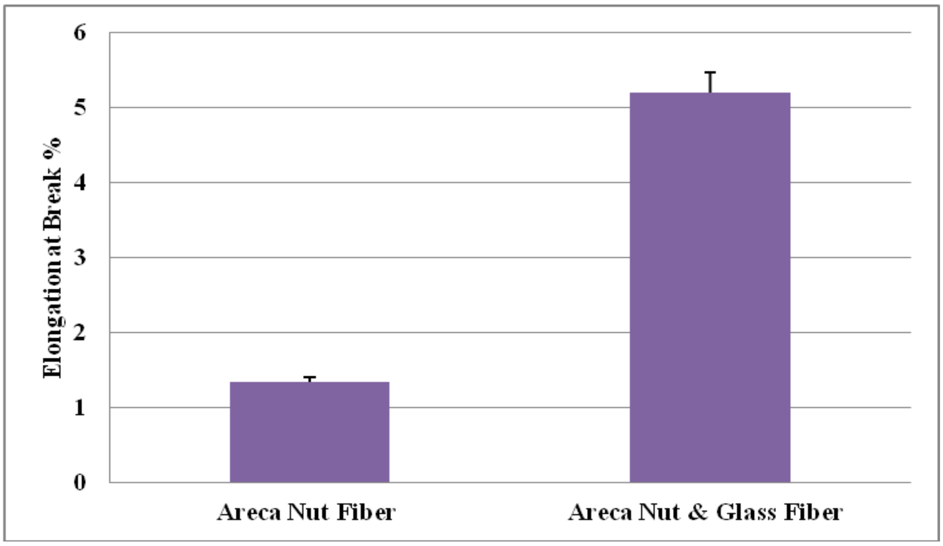

Fig.4.4: Elongation properties of Areca nut fiber and Areca nut fiber & Glass hybrid composite

FLEXURAL STRENGTH:

During flexural testing of composite materials, when force has been applied on the samples, it has tended to break and before breakage it deformed to the breaking point. Flexural strength, young's modulus, deformation at break of the fabricated samples were determined. Flexural strength of Areca nut fiber & Epoxy composite and Areca nut fiber & Glass hybrid composite specimens are presented in the Fig. 4. The maximum flexural strength recorded for hybrid composite sample was found to be 9.513MPa. The Areca nut fiber & Epoxy composite shows flexural strength of 1.176 MPa which is lower than the hybrid composite. It is evident from the figure that, hybridization of glass fiber with areca nut fiber increased the flexural strength dramatically. All composites are failed in brittle manner the fractured specimens are shown in Fig.4.5

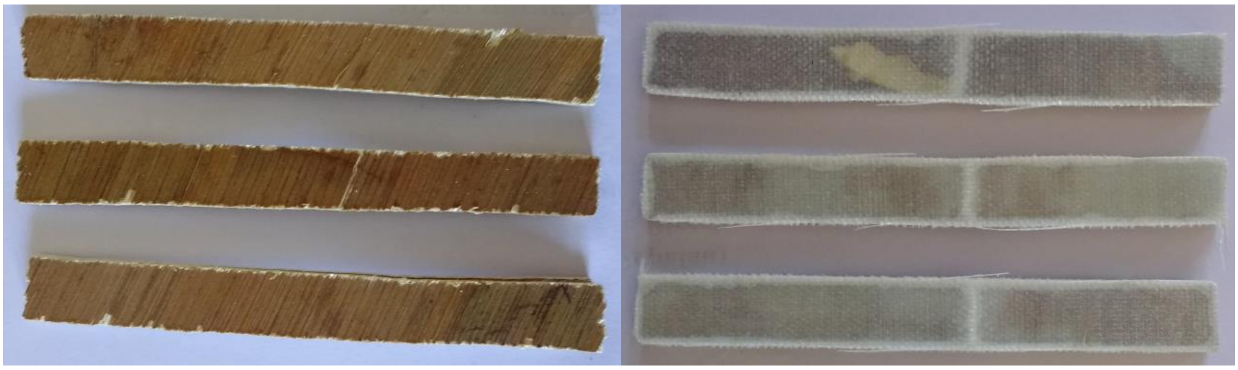

Fig.4.5: Tensile Fractured specimens of Areca nut fiber and Areca nut fiber & Glass hybrid composite

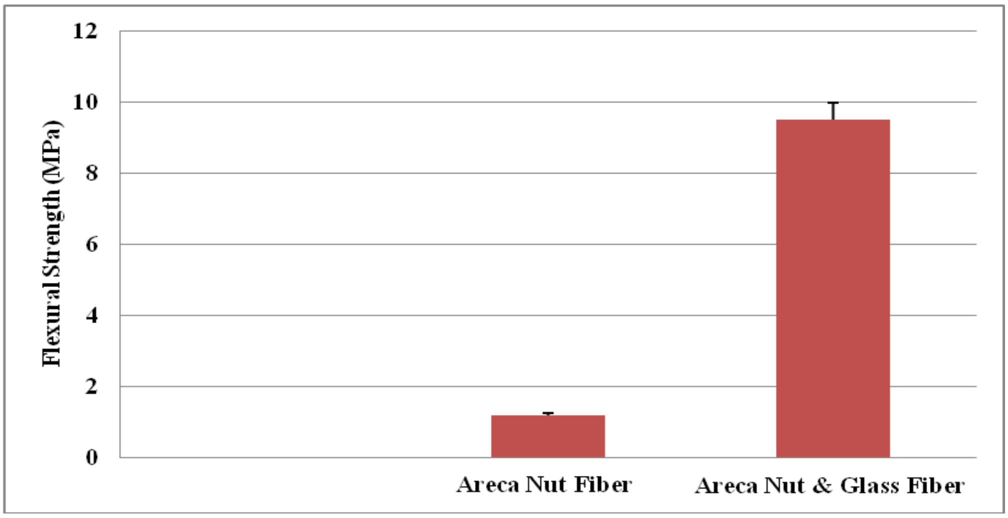

Fig.4.6: Comparison of flexural strength of Areca nut fiber and Areca nut fiber & Glass hybrid composite

YOUNG'S MODULUS:

Young's modulus of Areca nut fiber and hybrid composite is illustrated in the Fig. 4.7. It is observed that young's modulus of the tested specimens shows the similar pattern like flexural strength. Areca nut fiber & Epoxy composite specimen shows the lowest young's modulus of 11.495 MPa. On the other hand young's modulus increased as 113.44 MPa and reaches the topmost point after hybridization of glass fiber within Areca nut fiber & Epoxy composite. This may be due to the higher strength and stiffness of glass fiber. Similar effect was reported by the researchers Wambuaet.al [5].

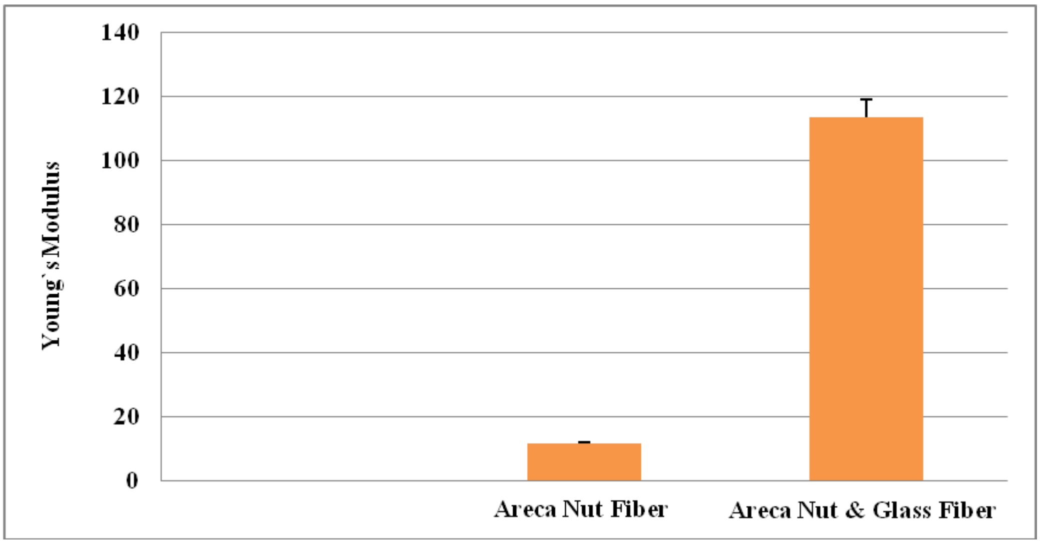

Fig.4.7: Comparison of young's modulus of Areca nut fiber and Areca nut fiber & Glass hybrid composite

DEFLECTION AT BREAK:

The failure force for Areca nut fiber & Epoxy composite and hybrid composite samples are demonstrated in the Fig. 4.8. It is apparent in the Figure that hybrid composite undergoes greater deflection compared to Areca nut fiber & Epoxy composite. The deflection of hybrid composite before failure is found to be 10.13 % whereas Areca nut fiber & Epoxy composite shows decrease in the deflection percentage. These results can be substantiated from the research of Wambua et al [5]. They showed that glass fiber has greater extensibility than the areca nut fibers.

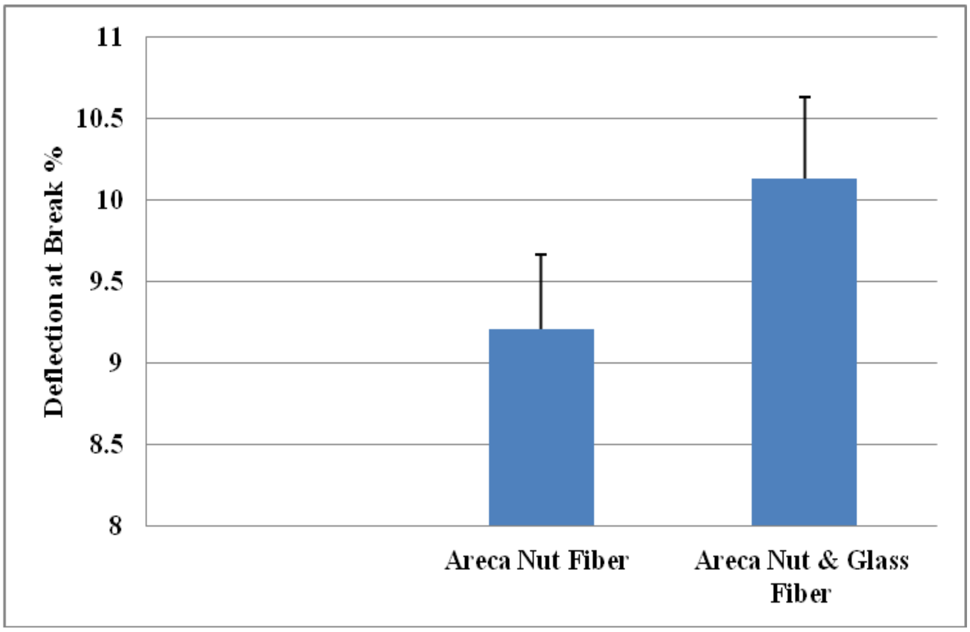

Fig.4.8: Deflection properties of Areca nut fiber and Areca nut fiber & Glass hybrid composite

V. CONCLUSION

Natural fiber composites could be asserted as the savior of the world. Its viability in the diversified application makes it the most advanced material. Once people changed their belongings according to the available materials but now we can fabricate any material according to purpose. Natural fiber like areca nut fiber is cheap, available and friendly to environment. Investigations illustrated that the use of glass fiber in a areca nut fiber composite substantiate its mechanical properties. Hence areca nut fiber & Glass hybrid composite can be a good solution for high strength work with less environmental degradation. The results discussed above can possible to enhance mechanical performance of hybrid fiber reinforced composites through hybridization of areca nut fiber & Glass hybrid composite with Epoxy matrix. Which may be find diverse applications as structural materials where strength and cost considerations are important.

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