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EXPERIMENTAL INVESTIGATION ON FLEXURAL PROPERTY OF ABACA AND RAFFIA HYBRID COMPOSITES

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ABSTRACT

Presently natural composites are playing vital role in automotive industries. Due to their high specific strength and modulus, they are replacing many metallic structures. This paper deals with fabrication and investigation of flexural property of natural fibre composites using abaca and raffia fiber. In this work, the composite is manufactured by hand layup process. `Three different types of composites were fabricated and their flexural property was investigated. The result shows that the Raffia - glass fiber composite has very high strength as compared to other two composites. Morphological analysis was carried out to analyse the internal structure of tested specimens.

Keywords: abaca , raffia, glass fiber reinforced polymer (GFRP), hand layup method, flexural property.

1. INTRODUCTION

In recent years, fibre reinforced polymer composites play an important role in various applications. Due to the increased environmental awareness, the concern for the growing global wastage problem and environmental sustainability is increased. The applications of natural composites to component design through polymers are limited by the hydrophilic nature of the cellulose. The success of combining vegetable natural fibres with polymer matrices results in improvement of mechanical properties of the composites compared with matrix materials [1]. The physical properties of natural fibres are mainly determined by the chemical and physical composition such as the structure of fibres, cellulose content, angle of fibrils, cross section and by the degree of polymerization [2]. Compared to most synthetic fibres, natural fibres are economical, easier to handle, have good specific mechanical properties [3]. The thermal properties of banana-flax based natural fiber composites are studied and it is experimentally verified that flax and banana hybrid natural composite has better thermal stability and resistance for flame over single fiber composites [4]. Manickavasagam *et al* [5] performed double shear and hardness tests on abaca and flax reinforced polymer composite and concluded that double shear and hardness of property of GRRP, abaca composite is higher than GFRP+Flax and GFRP+Flax+Abaca composites. Vijaya Ramnath *et al* [6] investigated of tensile behavior of Manila Fibre Reinforced Composite and concluded that manila hybrid composite has an average ultimate tensile strength is 31.66 MPa. Vijaya Ramnath et al (7, 8, 9) investigated mechanical behavior of Jute- Flax and Banana- Jute hybrid composite and found that hybrid composite has very high strength.

2. MATERIALS USED

a) Abaca

It is also called as Manila hemp. Abaca is extracted from the leaf sheath around the trunk of the abaca plant (*Musa textilis*), native to the Philippines and widely distributed in the humid tropics.

b) Raffia

Raffia fibre is obtained from the raffia palm of Madagascar. It can be made into a native cloth that is exported as rabanna. The raffia palm (Raffia farinifera or R. Ruffia) is crowned with enormous leaves that may be as much as 65 ft (19.8 m) long and composed of 80 to 100 leaflets. They grow up to 16 m tall and are remarkably noted for their compound pinnate leaves, the longest in the plant kingdom.

c) Resin and hardener

Epoxy resin (Araldite LY 556) has been used as a resin. This work also uses the Hardener (HY 951).

d) Glass fibre

Glass fibre is a lightweight, extremely strong, and robust material. Although strength properties are somewhat lower than carbon fibre and it is less stiff, the material is typically far less brittle, and the raw materials are much less expensive. Its bulk strength and weight properties are also very favourable when compared to metals, and it can be easily formed using moulding processes.

3. FABRICATION PROCEDURE

The technique used is hand layup process. First the glass fibre is cropped into a required number of plies of size 250 x 250 mm. The glass fibre is kept on the top and bottom most layer of the laminate. The natural fibres are chopped into minimum desired length. Then, Epoxy resin is applied completely over the glass fibre. Natural fibres weighing around 25-30 grams are spread in the resin applied glass fibre. Using roller, surface of the glass fibre is rolled to remove the entrapped air. Then a curing time of 5 to 6 hours is given for the top and bottom structures to obtain good strength. For each layer, resin

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hardener mixture is applied and rolled within 15 to 20 minutes to avoid drying of epoxy resin. Now a load (12 to 15 kg) is applied for a curing period of 12 to 18 hours on the mould. This gives the required composite laminates which can be cut to required size. In Abaca-Raffia-Glass composite, the plies are aligned in the order of intermediate glass fibres and natural fibres which constitute totally 4 plies. For example, in abaca-Raffia-glass composite, two plies of glass fibres and one ply of abaca fibre and one ply of Raffia fibre are aligned. Also in Abaca-Glass composite, Raffia-Glass composite the plies are aligned in the order of intermediate glass fibres and natural fibres which constitutes totally of 4 plies. For example, in abaca-glass composite two plies of glass fibres and two plies of abaca fibre are aligned.

4. TESTING OF MATERIALS

a) Flexural test

The flexural test method measures the behaviour of materials subjected to simple beam loading. It is also called as transverse beam test with some materials. Maximum fibre stress and maximum strain are calculated for increments of load. Results are plotted in a stress-strain diagram. Flexural strength is defined as the maximum stress in the outermost fibre. This is calculated at the surface of the specimen on the convex or tension side. Flexural modulus is calculated from the slope of the stress Vs. deflection curve. If the curve has no linear region, a secant line is fitted to the curve to determine the slope. The flexural test specimen is shown in the Figure-1.

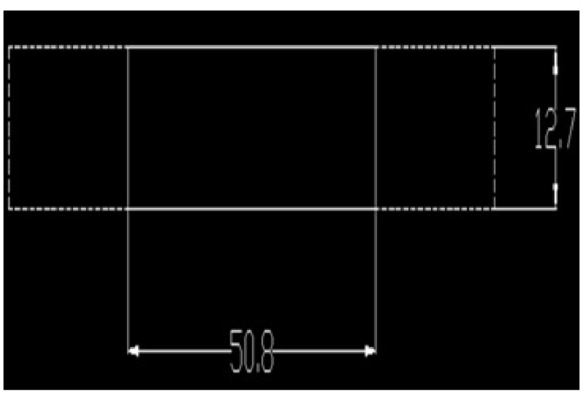

Figure-1. Flexural test specimen [ASTM: D790].

5. RESULTS AND DISCUSSIONS

a) Flexural test

Flexural test was conducted on the composite specimens namely ABACA, RAFFIA, ABACA + RAFFIA and the load Vs displacement graphs are plotted as shown in Figures-2, 3 and 4.

Composites	Break load (KN)	Displacement at (F_{max}) (mm)	Maximum Displacement (mm)	Ultimate Stress (kN/mm^2)
GFRP + ABACA	0.790	1.000	1.200	0.001
GFRP + RAFFIA	0.985	1.300	3.100	0.014
[illegible]	0.635	0.800	1.000	0.009

Figure-2. Flexural test – Abaca.

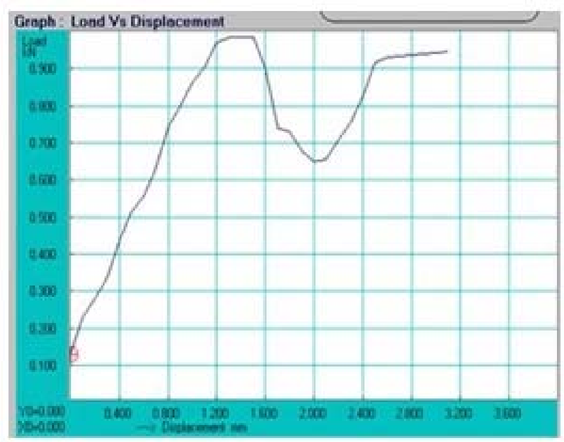

Figure-3. Flexural test – Raffia.

The above three graphs show the load and displacement values between the various composites. It can be seen that the flexural property of the Raffia GFRP composite is higher than other two specimens.

6. MORPHOLOGICAL ANALYSIS USING SCANNING ELECTRON MICROSCOPE

Morphological analysis is performed on the specimen in order to study about the surface characteristics once the flexural test is performed. Scanning electron microscope (SEM) uses the principle of bombardment of electrons and the reflection of secondary electrons to form the image of the specimen.

a) Sem image of the tested specimen

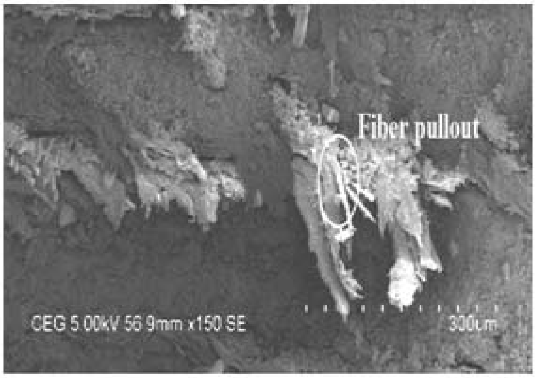

Figure-4. Flexural test SEM image.

7. CONCLUSIONS

This work is focused on the investigation of the flexural property of Abaca, Raffia, and Abaca + Raffia composites. The result shows that GFRP Raffia composite has good strength than other two composites.

Morphological analysis was performed using Scanning Electron Microscope. The surface properties and their characteristics were experimented through SEM after conducting tests. The samples were dried and coated with 15–20 nm thick gold layers using an Ion - Sputter coater device. From the SEM images of flexural tested specimen, it is seen from the Figure-4 and figure 5 that after the application of flexural stress on the specimen, the crack out first and then the adhesion starts breaking between the matrix and the resin. Since, abaca-raffia combination yields good strength, they broke collectively after the application of the tensile stress.

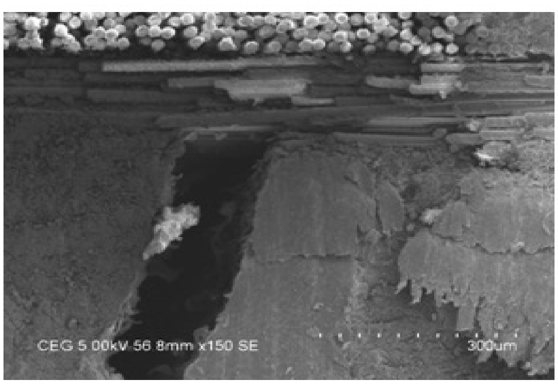

Figure-5. Flexural test SEM image.

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