Morphological and Comparative Characterization of Silk/Bamboo Fiber Reinforced Epoxy Composite

S. Subash, B. Stanly Jones Retnam, J. Edwin Raja Dhas, M. Sivapragash

Abstract---* *Composites are basically a combination of numerous components combined together to form a single bonding structure. Different types of composites are found around us in the form of concrete, balloons etc. are made up of multiple components which are reinforced in to matrix materials which posses exactly different nature. Though there are many types of composites available, polymer (epoxy) Matrix composites plays a very vital role. Basically the reinforcement in composites are made in order to increase the comfort level, reduce weight, increase strength, reduce cost and increase the durability of the material in turn it helps to serve the purpose. It's being said that most of the fibers used in the reinforcement posses less weight and are stronger than metals. In recent days the vehicle manufacturing Industries make use of this composite materials in order to increase the fuel efficiency by reducing the overall weight. This material gives a very appealing appearance to the exterior and good comfort in the interior at lower cost. In the past few decades the natural fibers started replacing the glass fiber reinforced polymer composites as they can be easily decomposed which does no harm to the ecological system of earth. Silk/Bamboo which is a natural fiber composite can be used as a good alternate for glass fiber or can be used along with the glass fiber in turn reducing the percentage composition of glass fiber. In this work silk/bamboo and glass fiber are used as reinforcement along with epoxy thermosetting plastic as matrix material are synthesized and tensile and SEM were done for the tensile fractured specimens. The properties are compared with each other to show the betterment.

Keywords---* *Fiber, Silk/Bamboo, Reinforced, composite, Epoxy.

I. INTRODUCTION

Conscious on reducing emission and reduction of non recyclable materials leads to the invention of recyclable and decomposable materials for various applications. Therefore the materials made out of natural materials played a very important role in present situation [1]. Polymers are most probably reinforced with fiber or filler materials to gain superior mechanical properties [2]. Natural fibers have tremendous advantages when compared with artificial fibers for instance acceptable specific properties, low density, cheaper as well as they are reproducible and recyclable. They acquire high power and firmness, excellent thermal and sound insulating property and high confrontation to breakage. on the other hand, the main drawback of these natural fiber/polymer composites seem to be the compatibility among the hydrophilic natural fibers and the hydrophobic matrix that make compulsory to use compatibilizers or pairing agents in order to develop the bond among fiber and matrix [3]. The brisk development of the expertise for manufacturing industry goods contribute customer the simplicity of making a appropriate option and own attractive taste. Researchers have extended their knowledge in the product plan by applying the usage of unprocessed materials like bamboo fiber which is stronger as well as can be utilized in generating high end quality sustainable industrialized goods. This editorial gives serious appraisal of the most up to date development of bamboo fiber based durable composites and the outline of main results offered in literature; focus on the processing style and eventual properties of bamboo fiber with polymeric matrices and applications in well planned inexpensive products [4]. The vibrant tensile test shows that 1-year-old bamboo has the best tensile strength (251MPa), which is1.85 times that of aluminium alloy. The drop-weight test show that the energy absorption of nodal specimens is better than that of the inter node specimens. The results point out that bamboo is a tubular constitution with outstanding mechanical and energy inclusion properties.[5]. Natural fibers are of lesser cost and comprise of lower density compared to artificial reinforcement products and hence present benefits for use in marketable applications [6]. Tough and eco-friendly host-guest approach to manufacture metallic cobalt nano particles fixed in N-doped carbon fibers resulting from natural silk fibers.[7] Silk fiber has been commonly used for bio-medical engineering and surgically-operational applications for centuries since its biocompatible and bioresorbable properties. Using silk fiber as strengthening for bio-polymers might enhance the firmness of scaffoldings and bone implants [8]. exterior treatment of natural fibers for bond development is a critical step in the improvement of bio-composites. Different treatment such as pre-impregnation, surface modifications, chemical reactions and plasma were studied for improving their interfacial bonding strength of composites [9-13]. The handlings of plant fiber not only suit all the needs of the composites. Therefore, introduction of hybrid plays an important role in the development the mechanical properties of the FRP composites [14].

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II. MATERIAL

The materials are fabricated using epoxy resin as matrix material which is a thermosetting plastic and Silk/bamboo fiber along with glass fiber is used as reinforcement. The fabrication of the specimen is done by high-volume thermoset compression *molding* process. The composite plates are made in three combinations as shown in Table 1 of size 150X150X10 mm. The different compositions of the specimen are, specimen A is made with epoxy and silk fiber in the ratio of 70:30 in weight percentage. The specimen B is made with epoxy, silk and bamboo fiber in the ratio of 70:20:10 and finally the specimen C is made with the epoxy, silk and E-glass fiber in the ratio of 70:20:10 in weight percentage.

Table 1: Compositions of Composite Plates in Wt%

Specimen	Combinations	Wt %
A	Epoxy Silk fiber	70% 30%
B	Epoxy Silk Bamboo	70% 20% 10%
C	Epoxy Silk E-Glass	70% 20% 10%

III. EXPERIMENTAL PROCEDURE

The composite plates are made using compression molding process. Three different plates combination are made A,B and C. The plates were cut in to tensile specimens as per ASTM D- 638 standards .For each combination three different specimens were taken and tested .The specimens were tested in a computerized UTM rotated at a speed of 2mm per revolution in the environmental climatic condition. This test was conducted by holding the two ends of the specimen and pulling it until fracture. The mean value among the three specimens were taken for the final result. Then the fractured specimens were subjected to metallurgical test on the fractured area by scanning electron microscope and the morphological study is done.

IV. RESULT AND DISCUSSION

Tensile Test

The tensile properties of the specimen derived are shown in the Table 2. The properties such as ultimate tensile strength, yield strength, young's modulus and % elongation are obtained. The results are displayed as follows.

Table 2: Tensile Property of Specimen with Respect to Combination

Specimen	UTS in (MPa)	Yield Strength (MPa)	Young's Modulus (MPa)	Elongation (%)
A	22.7	13.56	360.44	1.67
B	32.64	21.73	342.31	2.01
C	82.44	38.61	586.12	3.16

Figure 1. Represents the chart for the specimen vs ultimate tensile strength for all the three specimens. The specimen C posses the highest UTs of 82.44 MPa for he addition of 10 Wt % of E-glass fiber followed by 20 Wt % of Silk fiber with 70 Wt % of epoxy as Matrix material. This is followed by specimen B with 32.64 MPa UTS for the combination of 10 Wt % bamboo fiber, 20 Wt % silk fiber in 70 Wt % Matrix. The lowest result among this is given by epoxy 70 Wt % and silk fiber 30 Wt % in specimen A, the UTS value is 22.7 MPa and is the least when compared to the other two specimens. Figure 2. Shows the graph for the specimen vs yield strength in MPa for the specimen samples A,B and C. Among this the specimen C posses highest yield strength of 38.61 MPa for the addition of 10 Wt % of glass fiber along with Silk fiber. This is followed by specimen B for 10 Wt % addition of bamboo fiber along with silk fiber, the yield strength of 21.73 Mpa is obtained. The least value is obtained with pure silk and epoxy composition specimen A.13.56 MPa is the yield strength obtained for specimen A.

Figure3. illustrates the Young's modulus of the specimens of the specimens where the specimen C posses a considerable modulus of 586.12 MPa followed by specimen A and B with 360.44 MPa and 342.31 MPa respectively. The specimen with glass fiber composition posses a better stiffness when compared to specimen with Pure silk which comes second and specimen with Bamboo combination comes in third position.

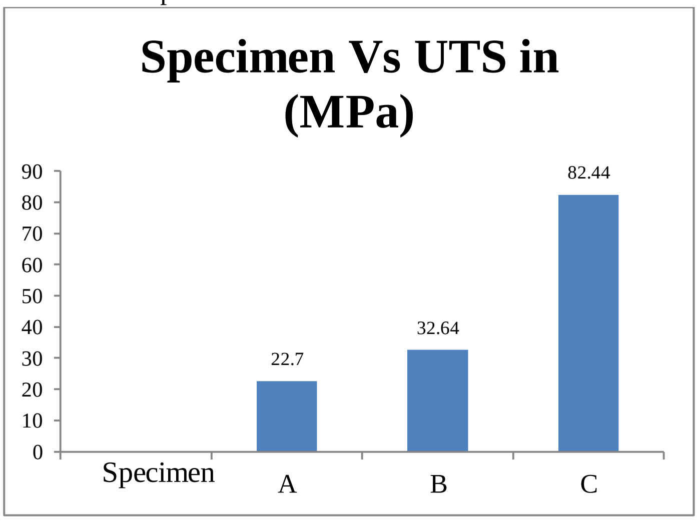

Fig. 1: Specimen Vs ultimate tensile strength in MPa

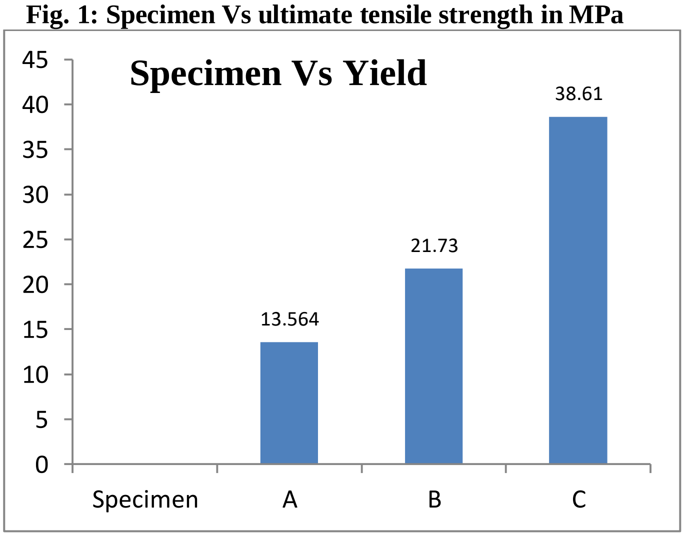

Fig. 2: Specimen Vs Yield strength in MPa

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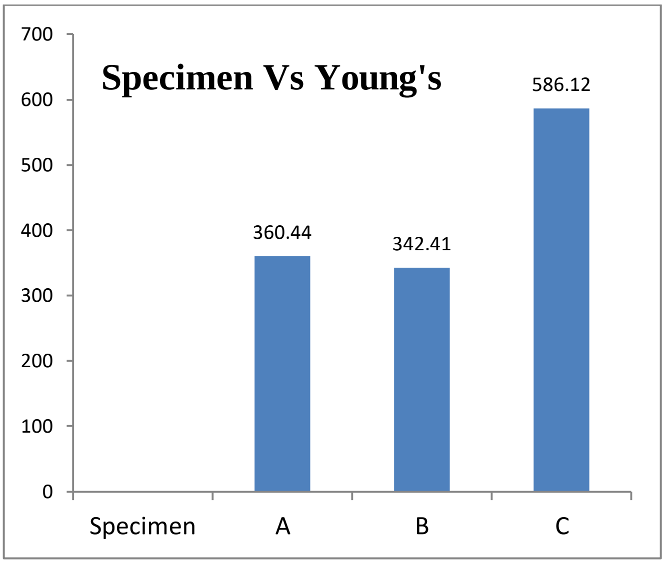

Fig. 3: Specimen Vs Young's Modulus in MPa

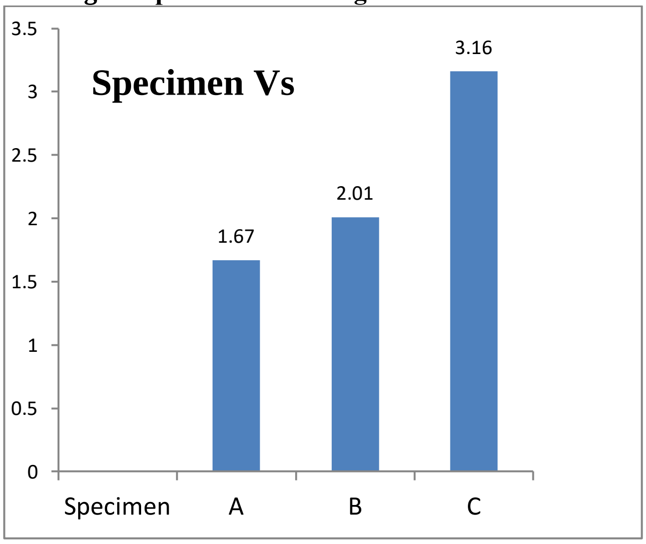

Fig. 4: Specimen Vs Elongation in %

Figure 4. Represents the specimen Vs Elongation in percentage. The specimen A with glass fiber composition elongated 3.16 % where as the specimen B with bamboo fiber composition elongated 2.01% followed by specimen with pure silk composition elongated only 1.67%.The result shows that there is enhancement in elongation when bamboo fiber and E-glass fiber is being added along with silk fiber.

SEM Test

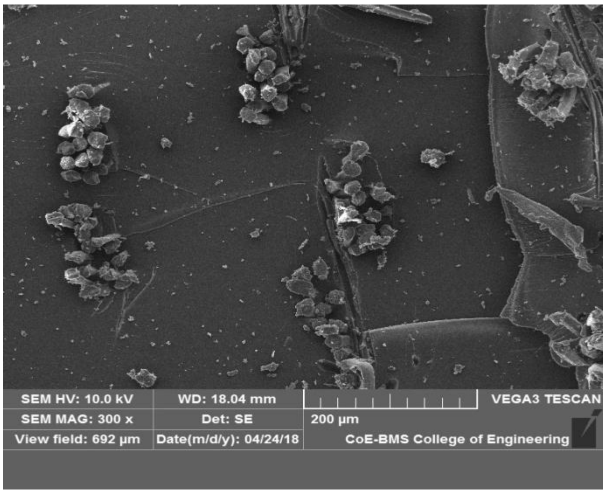

Fig.5: SEM microstructure for specimen A

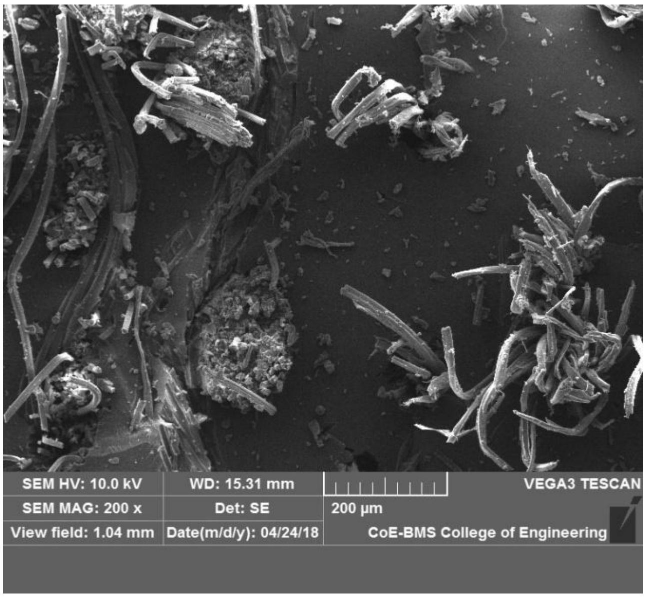

Fig.6: SEM microstructure for specimen B

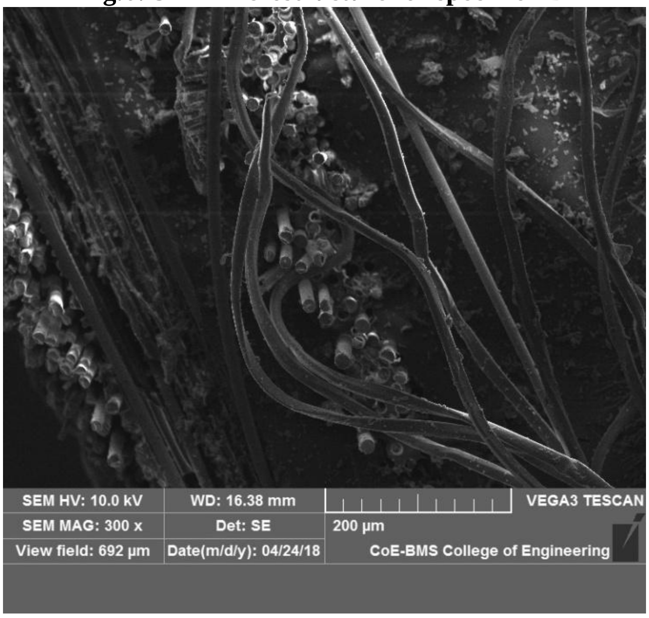

Fig.7: SEM microstructure for specimen C

The Morphological study is conducted on the specimens using Scanning Electron Microscope and the following images are obtained as results.

Figure 5. Shows the SEM microstructure of specimen A with the composition of pure silk fiber wit Epoxy resin. The image reveals that clear bonding between the matrix and the reinforcement with no fiber pullouts. This clearly shows tensile fracture of the specimen.

Figure 6. Illustrates presence of bamboo fiber along with silk fiber and Epoxy as matrix material. The image shows that the fibers running in cris- cross direction o each other. This helps to improve the bonding strength of the material.

Figure 7. Represents the presence of glass fiber with silk fiber. The glass fiber provides additional strength in addition to silk fiber.

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V. SUMMARY

The usage of silk and glass fiber has been adequately increased and can be used as a good alternative or along with the glass fiber due to the following reasons.

The addition of bamboo fiber along with silk replaced glass fiber in specimen B gives increase of 9.94 MPa UTS, 8.17 MPa increase in yield strength and 0.34 % increase in elongation when compared to pure silk alone. But it has 18.03 MPa lesser modulus when compared to pure silk composites.

The replacement of bamboo fiber with E-glass fiber gives a drastic increase in properties in specimen C when compared to specimen B. The UTS of specimen C has increased to about 49.8 MPa when compared to B and 16.88 MPa Yield strength, 243.71 Mpa Young's modulus, 1.15% elongation when compared to specimen B.

The SEM Microstructure shows that all the specimen with fiber reinforcement shows a better bonding strength.

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