Proceedings of the International Conference on Applied Mechanical Engineering Research (IC-AMER2019)
NIT Warangal, India – May 02-05, 2019
Paper No. XXX (The number assigned when the papaer is accepted)

Mechanical Characterization of Unidirectional Banana-Glass Fiber Reinforced Hybrid Composites

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ABSTRACT: This study has been undertaken to mechanical characterization of banana-glass fiber reinforced epoxy hybrid composites. Natural fibers have higher economic impact and miniature in density when compared to glass fibers while making composites. Though the strength of the natural fibers is not as high as glass fibers, these specific properties are comparable. In this work a study has been carried to characterize the mechanical properties of hybrid composites made by intruding unidirectional banana and unidirectional glass fibers in to epoxy resin mixture. The hand layup method of fabrication was employed in preparing the composite laminates of unidirectional banana-glass fiber. The objective of present work is to evaluate and compare the mechanical properties of laminates such as tensile strength, flexural strength and impact strength of different stacking sequence of unidirectional banana and glass fabrics.
***Keywords*:** Hybrid Composites, Tensile Strength, Flexural Strength and Impact Strength

INTRODUCTION

In the recent years there has been an increasing environmental consciousness and awareness of the need for sustainable development, which has raised the interest to engineers, scientists, professionals and research scholars to focus on natural fibers. Natural fibers acts as an alternative reinforcement for composites because of it advantages like low density, high specific weight and low cost, eco-friendly, and bio-degradable in nature to replace the synthetic fibers [1]. This good ecological friendly features makes the materials exceptionally mainstream in building markets, like automobile and construction development industry [2]. The fusion of natural fibers with glass fiber increases its mechanical properties and these composites can be utilized for medium strength applications [3].k. palanikumar et al. [4] studied the tensile properties of unidirectional banana and glass fiber reinforced epoxy composites and compared the results with single reinforced composite in both experimental and numerical analysis tests. From the test results it is found that unidirectional Glass fiber reinforced composite possess higher tensile strength 567 MPa than the unidirectional banana–glass reinforced composites. M.R. sanjay et al. [5] presented the mechanical and physical properties of Banana and E-Glass fabrics reinforced polyester hybrid composites. In this different composition of banana and E-glass fabric laminates are fabricated by using hand layup and vacuum bagging methods. The testing of composite specimens are performed according to the ASTM standards. From the test results it is observed that the higher tensile strength, flexural strength, impact strength and hardness values are found in glass fabric laminate and while it is low for banana fabric laminate. Sandhyarani Biswas et al. [6] presented the physical and mechanical conduct of unidirectional banana/jute fiber reinforced epoxy based hybrid composites and compared it with the single natural fiber reinforced composites. From the observed results it is found as the fiber loading increases the void content of the composite also increases. M. Ramesh et al. [7] investigated the processing and mechanical evaluation of banana fiber reinforced with epoxy based composites. In the present study, developed hybrid composites of unidirectional banana and glass fibers. Epoxy resin was used as the matrix for these composites. The effect of fiber content on the mechanical properties viz. tensile, flexural, and impact properties have been studied for these hybrid composites.

EXPERIMENTAL DETAILS

Materials

The materials which are used in fabrication process is unidirectional banana fabric, unidirectional E-glass fabric, Epoxy resin LY556, Hardener HY951, acetone, wax, and transparent sheet. The unidirectional banana fabric is purchased in the form of Mats from Go Green Products private Ltd from Chennai, India. The unidirectional E-Glass fabric, epoxy resin, Hardener and acetone are bought from a local retailer in Hyderabad.

Preparation of Composite Laminates

In this preparation process the hand layup method is adopted for the fabrication of composite laminates. Before to start the process the mould of dimensions 365 mm X 365 mm has to be cleaned with acetone in order to remove impurities present on the mould surface. Then the transparent sheet is placed over the mould surface and wax is applied to it for an easy removal of laminates from the mould. The unidirectional banana and unidirectional E- glass fibers are cut according to the mould dimensions. The Epoxy resin LY556 and hardener HY951 are mixed in the proportion of 10:1 and mix thoroughly with the help of mechanical stirrer. For every laminate the different combinations of banana and E-glass fabric laminates are prepared to obtain the required thickness of the laminates and named as L-1, L-2, L-3, L-4, L-5 and L-6 and their detailed composition and designations are shown in the below Table 1.

Table. 1. Stacking sequence of laminates

Laminates	Composition of Fiber (%)		Stacking Sequence
	Banana (B)	Glass (G)	
L-1	0	100	G+G+G+G+G
L-2	20	80	G+G+B+G+G
L-3	40	60	G+B+G+B+G
L-4	60	40	B+G+B+G+B
L-5	80	20	B+B+G+B+B
L-6	100	0	B+B+B+B+B

MECHANICAL TESTING

Tensile Strength

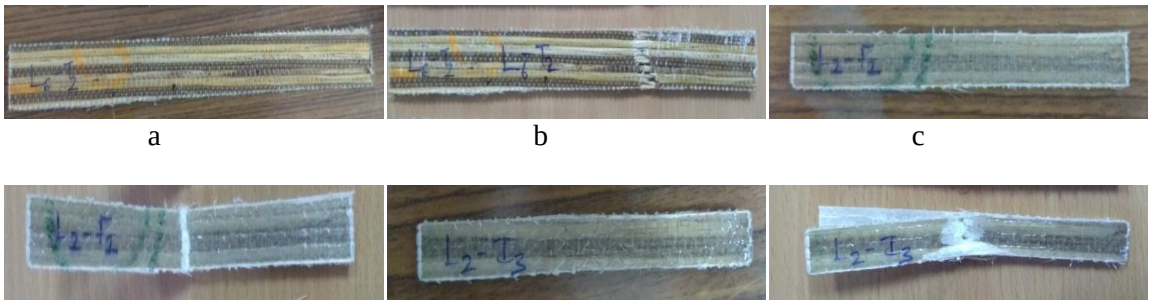
In present work the tensile test is performed on flat specimens. The standard for tensile properties of fibre reinforced composites is ASTM D 3039. The dimensions of the composite specimen as per ASTM standard are 250 mm X 25 mm X3 mm for longitudinal direction. The tensile test is conducted on computerized UTM of model Instron 1195 at a speed of 10 mm/min and load of 25 kN. The tensile test specimen of unidirectional banana-glass fiber reinforced epoxy hybrid composite is shown in Figure 1(a).

Flexural Strength

The flexural test performed in this is three point bend test. The standard for flexural properties of fiber reinforced composites is ASTM D 790. The dimensions of the composite specimen as per ASTM standard are 125 mm X 13 mm X 3 mm for longitudinal direction. The flexural test is conducted on computerized UTM of model Instron 1195 at a speed of 10 mm/min and at a load of 25 kN. The flexural test specimen unidirectional banana-glass fiber reinforced epoxy hybrid composite is shown in Figure 1(c).

Impact Strength

The Impact test was carried out on rectangular flat specimens. The ASTM standard test for impact properties of fiber reinforced composites as the designation ASTM D 256. The dimensions of the specimen are 100 *mm* X 10 *mm* X 3 *mm* for longitudinal direction. In the present work, the Impact test conducted was charpy impact test the specimen with a pendulum hammer, measuring the spent energy and relating it to the cross section of the specimen. The impact test specimen of unidirectional banana-glass fiber reinforced composite is shown in Figure 1(e).



a b c

d e f

Fig.1. Tensile, Flexural and Impact test specimens before and after testing

RESULTS AND DISCUSSION

The unidirectional Banana-Glass fiber reinforced epoxy Hybrid composite test specimens are tested in their relating testing machines. The various test specimens of laminates it's before and after failure modes are shown in the above figures. Then the ultimate tensile strength, ultimate tensile load, flexural strength, flexural modulus and impact strength of the composites are determined. For each laminate of different composition five test specimens are tested and the average values are obtained.

Tensile Strength Analysis

The ultimate tensile strength and ultimate tensile load of unidirectional Banana-Glass fiber reinforced with varying wt. % combination of hybrid composite was studied here, and its failure mode is shown in figure 1(b). The comparative bar graph charts for ultimate tensile strength of different laminates are presented in figure 2. Among the all six laminates the average ultimate tensile strength of the laminate L-1 is noted as 510 MPa with average ultimate tensile load 61 kN and average ultimate tensile strength laminate L-6 is noted as 55 MPa with average ultimate tensile load 6 kN. From this set of results tensile strength values are obtained when the natural banana fiber is hybridized with glass fiber a moderate strength is observed.

Flexural Strength Analysis

Flexural strength of unidirectional Banana-Glass fibre reinforced epoxy Hybrid composites was studied and its failure mode is shown in figure 1(d). The comparative charts for flexural strength of different laminates are presented in figure 3. Among the all six laminates the average flexural strength of the laminate L-1 is noted as 168 MPa and average flexural strength laminate L-6 is noted as 31 MPa. From this set of flexural values obtained when the natural banana fiber is hybridized with glass fiber a moderate strength is observed.

Impact Strength Analysis

Impact strength and energy absorbed of Banana-Glass fibre reinforced Hybrid composite was studied and its failure mode is shown in figure 1(f). Hybridization of Banana with glass plays a major role in the Impact strength. The comparative charts for Impact strength of laminates are presented in figure 4. Among the all six laminates the average Impact strength of the laminate L-1 is noted as 0.222 J/mm^2 and average Impact strength laminate L-6 is noted as 0.04 J/mm^2.

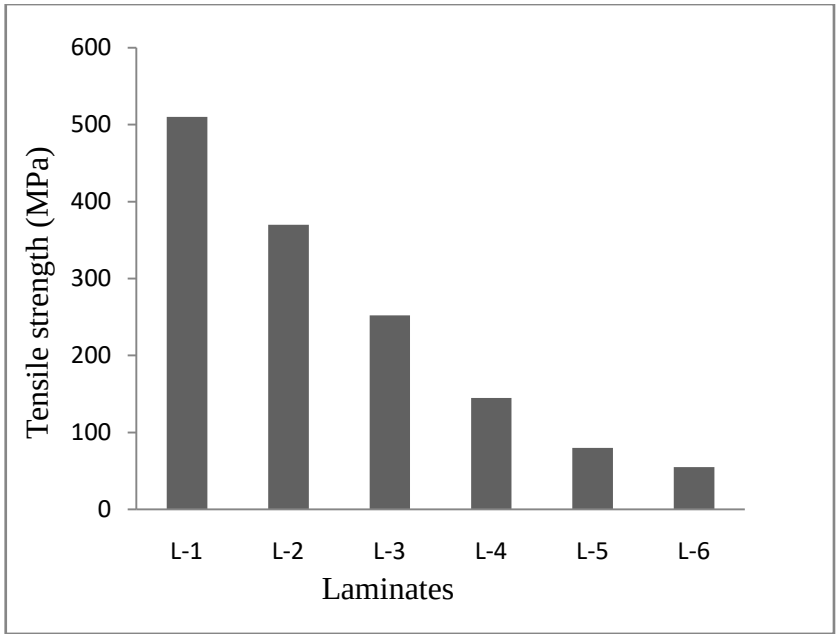


Fig.2. Tensile strength comparison chart

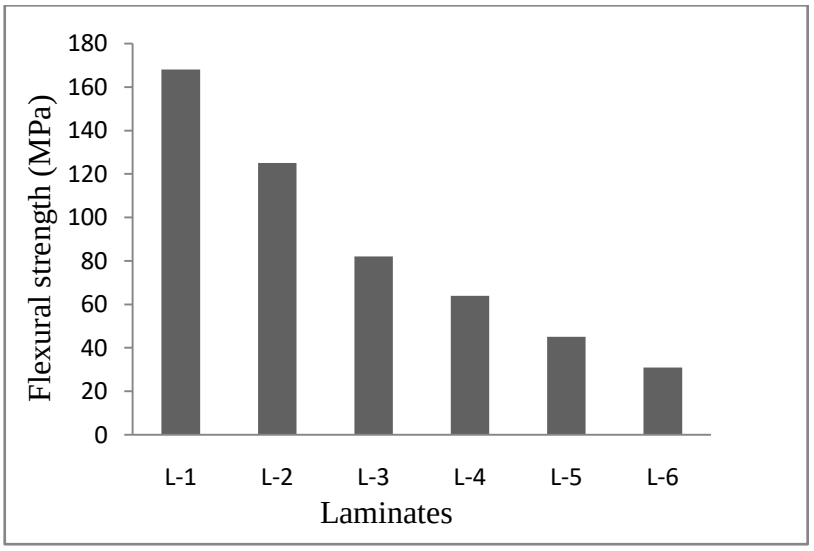


Fig.3. Flexural strength comparison chart

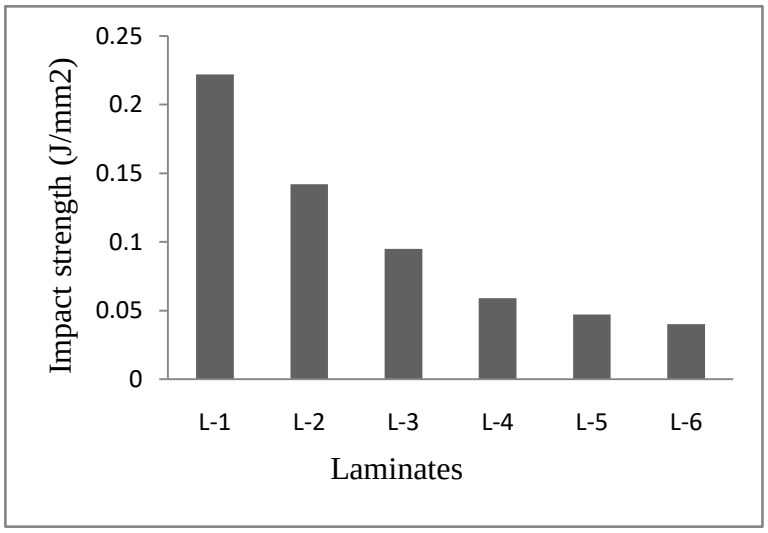


Fig.4.Impact strength comparison chart

CONCLUSIONS

The unidirectional Banana-Glass fiber reinforced epoxy based hybrid composites were fabricated by simple hand layup technique. It is found that as the glass layer in the laminates increases it mechanical properties enhances. When the natural fiber is hybridized with glass fiber a moderate strength is observed in the composites. These hybrid composites can be used for medium load bearing applications.

The unidirectional glass fiber composite possesses higher ultimate tensile strength among all the laminates and can withstand at ultimate tensile strength of 510 MPa at load 61 kN. The unidirectional banana composite possesses lower ultimate tensile strength of 55 MPa at load of 6 kN. From the flexural test results shows that laminate L-1 has the higher flexural strength 168 MPa and laminate L-6 has the lowest flexural strength 31 MPa. From the charpy impact test results it is noticed that the impact strength is high for the laminate L-1 of 0.222 J/mm^2 and while it is low for the laminate L-6 of 0.04 J/mm^2.

Acknowledgement

This research is funded by VNR Vignana Jyothi Institute of Engineering and Technology

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