Tensile Behaviour of Jute and Bamboo Fiber Reinforced Polymer Matrix Hybrid Composites

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Abstract: The fabrication of composites using synthetic fibers such as carbon, glass, aramid, etc is expensive because of higher cost of individual fibers. This requires alternative materials development with less production cost. Natural available jute and bamboo fiber were used as reinforcement in this present work. Natural fibers are inexpensive as compared to synthetic fibers and has emerged as a renewable and cheaper substitute to synthetic materials such as glass, carbon and aramid, which are used as reinforcements. In this work, the objective was to develop, investigate and analyze the tensile behavior of a composite material using bamboo fiber and jute fiber sandwich type composite. The results were studied and compared with the composite of bamboo fiber with epoxy resin. The experimental results shows that hybrid composites is having significantly greater values as compared to monolithic composites. The primary objective of the present work is to find out the effect of jute fiber on tensile properties of jute and bamboo reinforced hybrid composite.

1. Introduction

In the present century there is a huge demand for natural fiber reinforcement composites because synthetic usage fibers leads to mainly environmental pollution. Currently widely used natural fibers are sisal, banana, bamboo and jute were perfectly used in thermoplastics as well as thermo sets matrices. Natural fibers are widely used because of its advantageous properties such as availability of fibers inexpensive, less energy requirement, low density, higher strength, lower weight, height length to diameter ratio and height modulus of elasticity, these are all primary reasons for replacement of natural fibers in place of artificial fibers. The properties of bamboo fiber are as high as compared to artificial fibers like glass fibers. Number of fiber bundles and there stacking sequence plays major role for bamboo fibers hardness. Bamboo fibers are having high L/D ratio and mechanical properties. Bamboo fibers are very important reinforcements for polymer composites fabrication due to high length to diameter ratio and mechanical properties[1]

S. Syed Asif et al [1] investigated and analysed the mechanical performance of bamboo reinforced composites and fabrication methods of same composite by various methods. They carried out few research studies to find out the effect of fabrication parameters on the bamboo fiber mechanical behavior.

Pankaj et al [2] evaluated the bend/ flexural behavior and tensile behavior of bamboo and glass fiber dual reinforced hybrid composites which passes high flexibility and these are concluded by the evaluation of mechanical behavior which has significantly influenced by using glass and bamboo fibers in a alternate layer manner. The shear performance of soil is greatly effected with length of fibers[3].The tensile behavior of fiber laminated composites are compared with natural fiber reinforced with natural fiber reinforced composites[4]. Hingujam Jackson Sing [5] did extensive research on natural fiber composites and found out that these composites are best alternative sources incase of conventional components especially in electrical applications. Several researches also did extensive
work on synthesis and mechanical behavior of advanced composites [6-9]. Few researchers studied the machinability studies of natural components.

2. Experimental

2.1 Materials

The experimental work consist of preparing test samples, the samples are prepared made of bamboo fiber woven fabric epoxy laminates made of various orientation sequences have been prepared as per ASTM standards. Laminate is prepared by hand lay-up technique. In this research work specially designed mould is used to produce uniform thickness laminate and mild steel flat spacers with 5 mm thickness used to obtain uniform thickness. Pressure plate is made of the Mild steel with flatness 5mm thickness is maintained to meet the requirement to withstand the compressive force. This particular method of making laminate to ensure that the thickness of the laminates will be uniform with constant volume fraction of matrix and reinforcement. The matrix material used in this present study is a commercially available epoxy resin LY556.

2.2 Synthesis

Composite specimens are prepared according to the appropriate measurements in the current work. The bamboo fiber mat has been cut according to the appropriate dimensions by making use of various mechanical equipment and measuring equipment and then excess material is extracted on the surface of the mould and viscous liquid polyvinyl alcohol is applied evenly on the surface of the mold and left for about 15 minutes to dry. This liquid generates an invisible film that acts as an impermeable sheet.

Spacers are placed on the borders of the mould to get exact thickness of the laminate and uniform distribution of resin. Each layer of the fiber is kept in the mould and applying resin on to it, then the rolling is done by roller to distribute the resin evenly on to the layers. After completion of resin distribution on the layers, a Mylar film is applied to obtain the surface finish, while the uniform load is distributed on the layers after a pressure plate is placed on the layers and exact thickness occurs through the spacers. It took 24 hours to get the appropriate laminate, while the pressure plate and Mylar film were removed and the laminate was removed from the mould after removal. For various different layers of sandwich composite laminates, the same procedures have been carried out shown in figure 4. As received bamboo fiber and jute fiber are shown in figure 1 and 2 respectively. The UTM used in this experimental work is also shown in figure 3.

![Figure 1. Bamboo Fiber (As Received)](image1)

![Figure 2. Jute Fiber (As Received)](image2)

The experimental work is also shown in figure 3.
3. Results and Discussion

Hybrid composite is successfully fabricated by using manual hand lay up technique and test specimens were prepared as per the ASTM D638 standards. All the test specimens are having approximately 10.5 mm width, 5.5 mm thickness and 50 mm gauge length. At ambient temperatures, tensile tests were performed at a cross-head speed of 5 mm/min. All the composites were observed failure at a load of 1544 N (Approximately) and it is also observed that major fiber bundle failure occurs at this magnitude of load. Load Vs displacement data is shown in figure 5. From the calculation the tensile strength value is found to be 26 MPa. After the major fiber bundle failure it is observed that load bearing capacity of the composites is slightly increased. This may be due to the stress produced in the surrounding fibers. Syed asif et all, did experimental work on tensile behavior of bamboo fiber reinforced composite material and the tensile stress is found to be 5.2Mpa[1]

From the above results it is observed that hybrid composites tensile strength value is 5 magnitudes greater as compared to bamboo reinforced composites. This is attributed to the significant contribution of jute fibers reinforcement in hybrid composites. Hence the jute and bamboo dual reinforced hybrid composites can be used for higher load structural applications. The percentage of elongation in the hybrid composites is 3 magnitudes greater as compared to bamboo reinforced composites, this result clearly reveals that hybrid composites is tough as compared to monolithic composites

| S.NO | Result               | value | Units |
|------|----------------------|-------|-------|
| 1    | Load At Yield        | 0.54  | KN    |
| 2    | Yield Stress         | 3.158 | N/mm² |
| 3    | Yield Load           | 0.800 | KN    |
| 4    | Tensile Strength     | 5.212 | MPa   |
| 5    | Elongation           | 1.12  | %     |
Table 2. Tensile Properties of Hybrid Composite

| S.No | Results                              | value | Units |
|------|--------------------------------------|-------|-------|
| 1    | Yield elongation                      | 4.22  | Mm    |
| 2    | Break force                           | 1543.6| N     |
| 3    | Tensile strength at Maximum           | 26.14 | MPa   |
| 4    | Maximum force                         | 1543.6| N     |
| 5    | % of elongation                       | 3.52  | Mm    |

Figure 5. load Vs displacement data of hybrid composites
4. Conclusions

1. Bamboo and jute dual reinforced hybrid composite is successfully fabricated by using hand layup technique.
2. Hybrid composites has shown significantly higher tensile strength, this may be due to the introduction of high strength jute fibers.
3. Percentage of elongation is also higher for hybrid composites; this clearly reveals that hybrid-composites absorb more energy before fracture as compared to bamboo reinforced composites.

5. References

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