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Development and testing of Pine Apple and Glass Fiber Reinforced Epoxy Hybrid Composites

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Abstract*: *Usage of Natural Fiber Composites (NFC) is increased rapidly due to the bio degradability nature of the fibers. These natural fibers are mixed with synthetic fibers to obtain better mechanical properties. In this study, pine apple and glass fiber reinforced epoxy composites are developed and their mechanical properties were evaluated. Composites were prepared by varying the fibers content and by using hand layup process with glass moulds of size 160 x 160 x 3 mm^3. The obtained laminates were sliced as per the ASTM criterion to test the properties. Higher glass fiber content in the composite specimen obtained higher mechanical properties. The composites can be utilized for the purpose of manufacturing components like doors panels, desks, roof tops etc.

Keywords*: *Pine apple fiber, Glass fiber, Epoxy, Hybrid composites, Mechanical properties.

I. INTRODUCTION

Utilization of NFC's is increasing day by day due to their properties like light weight and high strength. Composites are replacing the composite materials because of excellent properties like corrosion resistant, low cost, environmental friendly etc. using of these natural fiber composites in automotive applications minimizes the weight upto 60% thereby the efficiency of the automobiles increases. Nearly 60-80 percent of the component weight is reduced by using these composites [1]. Natural fiber composites have a drawback of fracture in fibers, delamination and matrix cracking. Bonding between matrix and reinforcement is the major issues in polymer composites. Matrix and fiber cracks while testing the samples for mechanical properties is the major issue [2-4]. In order to improve the adhesion bonding between matrix and reinforcement lot of researchers have worked on these issue. Krishnudu et al. [5] investigated on the improvement of mechanical properties by alkali treatment. The work concluded that fibers treated with alkaline improved the adhesive bonding such that the mechanical properties also improved. Madhuri et al. [6] investigated on the mechanical properties of the hardwika binata fiber reinforced composites, and the work concluded that increase in fiber content improved the mechanical properties. Based on the improvements in the properties and overcoming the difficulties of the composites scientists have centered to take into account necessities of household and mechanical applications. Krishnudu et al. [7] investigated on the filler content effect on the properties of the hybrid composites and concluded that the properties improved with filler content and decreased elongation of the composite. Optimization of the fiber and filler content on the responses like tensile strength and flexural strength were carried out by krishnudu et al. [8] in their another work. Many other researchers have worked on the improvements of the mechanical, physical and thermal properties, moreover their bonding characteristics have also been studied [9-10].

The present work investigates the mechanical properties of both the natural fiber and synthetic fiber contents in the composites. Pine apple natural fibre and glass synthetic fibers were used for the fabrication of composites in the study and effect on the properties and the results are observed meanwhile.

II. MATERIALS AND METHODS

In this work mainly two types of fibers are used; one natural fiber i.e., pine apple fiber and another one is synthetic fiber i.e., glass fiber with epoxy resin and hardener. Epoxy resin was Lapox (L12) and Hardener (k6) was purchased from the Yuje enterprises, Bangalore. The fibers, both pine apple and glass fiber were added to the resin for different weight percentages. The proportions of fibers used to fabricate composite laminates are shown in table 1. The detailed procedure for the fabrication of the composites can be found in the article [7]. The fabricated samples were tested for mechanical properties. The test specimens before testing is shown in figure 1.

Table 1 Composition of the fabricated composite laminates

Specimen	Glass Fiber	Pine Apple Fiber
SP1	10 grams	30 grams

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SP2	20 grams	20 grams
SP3	30 grams	10 grams
SP4	40 grams	-
SP5	-	40 grams

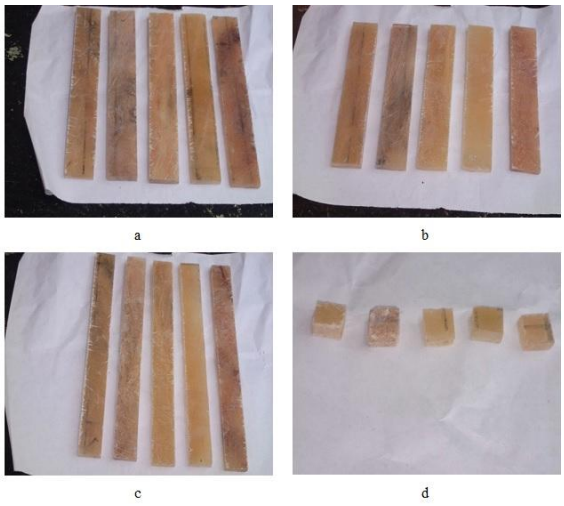

Fig. 1 Test specimens for a) tensile, b) flexural, c) impact and d) compression

The dimensions of the tensile test specimen are 150 x 20 x 3 mm^3 with different quantity of fibers as shown in figure 1(a). The dimensions of the flexural test specimen are 150 x 15 x 3 mm^3 with different quantity of fibers as shown in figure 1(b). The dimensions of the impact test specimen are 150 x 10 x 3 mm^3 with different quantity of fibers as shown in figure 1(c). For compression test 10 mm^3 is used as shown in fig 1(d). The testing equipments and their attachments are shown in fig. 2.

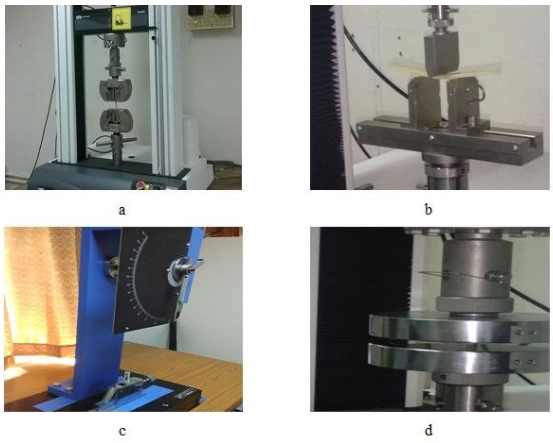

Fig. 2 Testing equipment a) tensile, b) flexural, c) impact and d) compression

A. Composite Testing

Mechanical tests like tensile, flexural, compression and impact were carried out as per the ASTM standards at the authors institute Kurnool, INDIA. For tensile, flexural and compression tests, INSTRON universal testing machine and for impact tests, IZOD impact tester were used.

III. Results and Discussion

The effect of both the fiber contents on mechanical properties was discussed in this section.

A. Results of Tensile Test

The test results of five samples are shown in fig.3. The tensile test results were improved with enhance in carbon content. Highest tensile strength of 192 MPa was observed for SP4 which has highest content of glass fiber, least tensile strength of 111 MPa is experiential for SP5 which has the highest content of pine apple fiber with no glass fiber. An increase of 73% is observed for SP4 when compared to SP5.

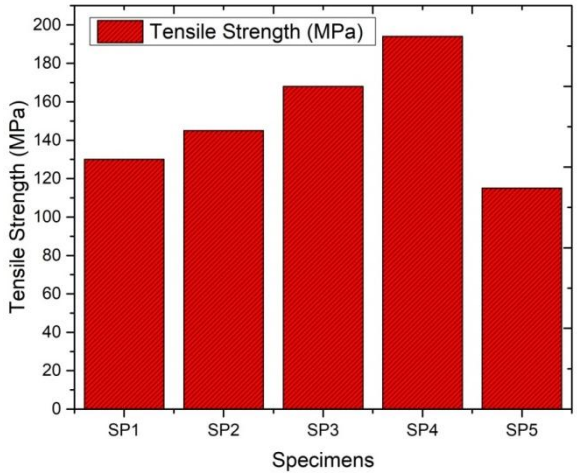

Fig. 3 Tensile strength of various proportions of fibers reinforced hybrid composites

B. Results of Flexural Test

The test results of five samples are shown in fig.4. The flexural test results were improved with enhance in carbon content like as tensile test results. Highest flexural strength of 142 MPa was observed for SP3 which has 30 wt% of glass fiber and 10 wt% of pine apple fiber, least flexural strength of 101 MPa is observed for SP5 which has the highest content of pine apple fiber with no glass fiber. An increase of 34% is observed for SP3 when compared to SP5.

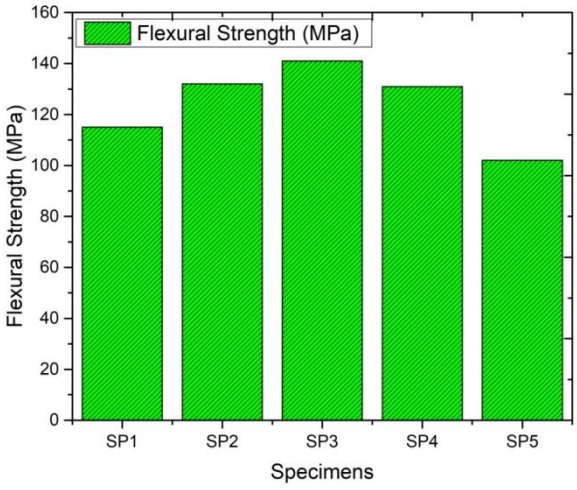

Fig. 4 Flexural strength of various proportions of fibers reinforced hybrid composites

C. Results of Impact Test

The test results of five samples were shown in fig.5. The impact test results were improved with enhance in carbon content like as tensile and flexural test results.

Highest impact strength of 412 J/m was observed for SP4 which has highest content of glass fiber and least impact strength of 201 J/m was observed for SP5 which has the highest content of pine apple fiber with no glass fiber. An increase of 104% is observed for SP4 when compared to SP5.

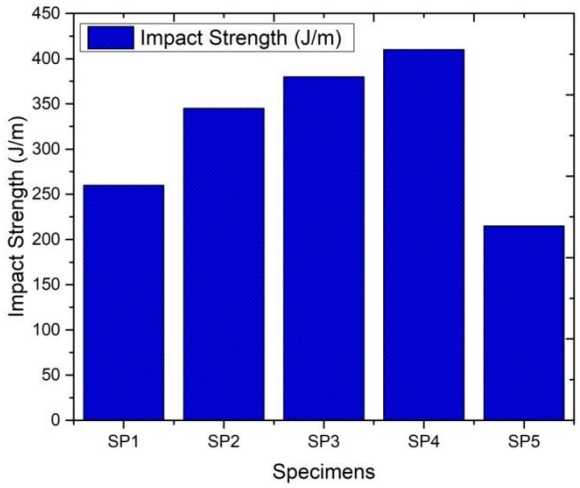

Fig. 5 Impact strength of various proportions of fibers reinforced hybrid composites

D. Compression Test Results

The test results of five samples were shown in fig.6. The compression test results were improved with enhances in carbon content like as tensile, flexural and impact test results. Highest compression strength of 172 MPa was observed for SP4 which has highest content of glass fiber and least compression strength of 81 MPa is observed for SP5 which has the highest content of pine apple fiber with no glass fiber. An increase of 112% is observed for SP4 when compared to SP5.

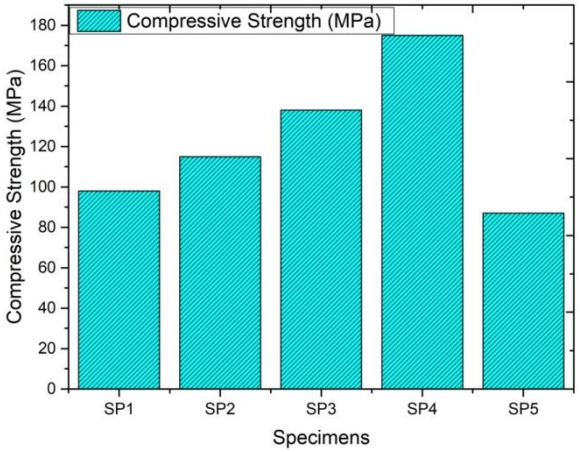

Fig. 6 Compressive strength of various proportions of fibers reinforced hybrid composites

IV. CONCLUSION

The glass and pine apple fiber reinforced epoxy hybrid composite specimens were prepared and subjected to mechanical tests. The below conclusions were observed from the tests:

1. High carbon fiber substance in the composite increased the tensile, compression and impact strengths when evaluated to pine apple fiber samples.
2. 30 wt% of glass fiber and 10 wt% of pine apple fiber has highest flexural strength.
3. When evaluated to pine apple fiber composite glass fiber composite has an improvement of 73% tensile strength.
4. When compared to pine apple fiber composite glass fiber composite has an improvement of 104% impact strength.
5. When compared to pine apple fiber composite glass fiber composite has an improvement of 112% compressive strength.
6. When compared to SP5 composite SP3 has an improvement of 34% flexural strength.

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