Mechanical Properties of Hybrid Reinforced polymer Composite

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***Abstract*—Composites are a mixture of two or more constituent materials where the performance of composites is best that their constituent materials acting alone. The manufacturing of composites provide a means of improving strength, stiffness, resistance to temperature creep of composites while at same time offering cost reduction, Natural fibers as reinforcement as they are environmentally friendly, renewable, non-abrasive, eco-friendly, corrosion resistance and biodegradable characteristics.Pineapple is one of the natural fibers having highest cellulosic content nearly 80%. Density of PALF is similar to other natural fibers while Young's modulus is very high, and tensile strength is highest among the related natural fibers. The Borassus fibers are extract the fruit. Low cost natural fiber composites with excellent thermal insulation properties are fabricate from borassus fiber by varying volume fraction using polyester resin. In this research work fabrication of hybrid composite materials by using PALF and Borassus fruit fibers. These two materials mix with epoxy and resin, manufacturing new hybrid composite materials in different ratios. Evaluate mechanical properties of hybrid reinforced polymer composite materials.**

***Index Terms*—PALF(Pineapple leaf fiber) Borassus fruit fiber, Epoxy and Resin, Mechanical Properties.**

I. INTRODUCTION

Natural fibers have played a very important role in human civilization since prehistoric times. Natural fibers are substances which are prepared from plants and animals that can be converted into filament, thread or rope.The Natural fiber reinforced composite has improved earlier the attention of researchers because they are eco-friendly, light weight, strong, cheap, nonabrasive and excellent mechanical properties.

Low cost natural fiber composite with excellent thermal insulation properties was fabricated from the borassus seed shoot fiber by varying volume fraction using polyester resin. Thermal insulation of the composite increases as fiber content increased The results obtained from this work have significant potential benefits for thermal design of engineering applications like automotive parts , electronic devices, building constructions etc.The tensile property of the fiber was found to increase after alkali treatment due to improve fiber structure and found to be best 8 h alkali treatment. Mechanical properties and thermal properties like tensile strength, impact strength, flexural strength, thermal conductivity and thermal stability of the borassus fiber were found to increase after alkali treatment or water treatment.

Synthetic fibers can be partially substituted with PALF in fabrication of composite products for different applications. It is observed that recent works have reported on chemical modification of PALF, physical and mechanical properties of PALF reinforced polymer composites and its hybrid. Pineapple is one of the natural fibers having highest cellulosic content nearly 80%. Density of PALF is similar to other natural fibers while Young‘s modulus is very high, and tensile strength is highest among the related natural fibers. PALF is not degraded after long storage in hot and humid local conditions. Flexural and impact properties of PALF-reinforced vinyl ester composites are not affected by the presence of some epidermal tissues on the fibers and by the PALF location in the leaves.

II. METHOD OF MANUFACTURING SPECIMEN

A.Extraction of Borassus fruit fiber

Borassus fruit fiber is a natural fiber(Scientific name is CARYOTA URENS) of Arecaceae family and is used for making strong ropes. The borassus fruit fiber is extracted by a process is known as RETTING PROCESS .The borassus fruits were taken from the tree and immersed in water tank for 2to 3 weeks .After that the fiber were stripped from the stalks by hand. So that fiber will be remain. Washed and dried borassus fruit fiber was taken in separate trays to these trays 10% NaOH solution was added. Then the fiber was soaked in the solution for 10 Hours.After that the fiber were washed thoroughly with water to remove excess of NAOH sticking to the fiber.


Fig. 1 Borassus fruitsFig.2 Borassus fruits fibers

B.Extraction of pineapple leaf fiber (PALF)

Extract the pineapple leaf fibers (PALF) from leaves ofpineapple. Scrapping Method of Extraction is the machine used for scrapping the pineapple leaf fiber. The machine has the combination of three rollers: feed roller, leaf scratching roller, and serrated roller. Feed roller is used for the feeding of leaves into the machine then leaves go through the second roller that is called scratching roller. It scratches upper layer of leaf and removes the waxy layer. And at last leaves come to the dense attached blade serrated roller, which crushes leaves and makes several breaks for the entry passage for the retting microbes.

Retting of Pineapple Leaves In retting process, small bundles of scratched pineapple leaves are immersed in a water tank which contains substrate: liquor in 1:20 ratio, urea 0.5%, or diammonium phosphate (DAP) for fast retting reactions. Materials in water tank are regularly checked by using finger to ensure fiber are loosened and can extract many chemical constituents like pentosans, lignin, fat and wax, ash content, nitrogenous matter, and pectin. After retting process, fibers are segregated mechanically, through washing in pond water. Extracted fibers are dried in hanging place by air. So that only fibers will be remain. Washed and dried PALF were taken in separate trays to these trays 10% NaOH solution was added. Then the fibers were soaked in the solution for 10 hours. After that the fibers were washed thoroughly with water to remove excess of NaOH sticking to the fibers.

Fig. 3Pineapple Leaves and Pineapple fruit

fig. 4 Pineapple Leaf Fiber

C.Epoxy resin and Hardener

The resin and hardener mixture is used for binding various layers fiber. LY556 epoxy resin and HY951 hardener gives the better binding property under standard room temperature then other resin. An optimum mixing ratio of 10:1 between resin and hardener is used to followed by researchers suggestions.

D.Specimen preparation method

In this study, Manual hand layup method is used for preparing composite laminates. We have taken two plane glasses and fax is applied on top and bottom surface of glass. The LY556 epoxy resin and HY951 hardener mixture is completely applied. The specimens are manufactured borassus fruit fiber, pineapple leaf fiber and combination of borassus fruit fiber&Pineapple leaf fiber. The combination laminate composites are prepared by layer by layer up to three layers respective fibers. The first layer is Pineapple leaf fiber and applied epoxy and resin mixture. After that second layer of borassus fruit fiber is placed over the first layer. Then followed same way third layer of Pineapple leaf fiber is placed over the second layer. The specimen prepared as per ASTM-D 638 standard. Such as we have prepared four sheets these are 1.Three layer Borassus fruit fiber, 2.Three Pineapple leaf fiber, 3.Two Borassus fruit fiber and one layer pineapple leaf fiber, 4.Two layer Pineapple leaf fiber and one layer Borassus fruit fiber.

Fig. 5 Specimen laminated composites

Fig. 6 Testing samples

III. TESTING OF COMPOSITES

The main objective is to determine the material properties of natural fiber reinforced composite material by conducting the following respective tests.

A. Tensile Test

The specimen is prepared for tensile test according to the standards of ASTM D638 and the machine specifications are also chosen according to the ASTM D638. According to the ASTM D638 standard the dimensions of specimen used are 150 ×15× 3mm. This test involves inserting the specimen in a machine and subjecting it to the tension according to specific load till it fractures.

Fig. 7 Tensile testing machine

B. Flexural Test

The flexural specimens are prepared as per the ASTM D638 standard. The 3-point flexure test is the most common flexural test for composite materials. Specimen deflection is measured by the crosshead position. Test results include flexural strength and displacement. The testing process involves placing the test specimen in the universal testing machine and applying force to it until it fractures and breaks. The specimen used for conducting the flexural test. According to the ASTMD638 standard the dimensions of specimen used.

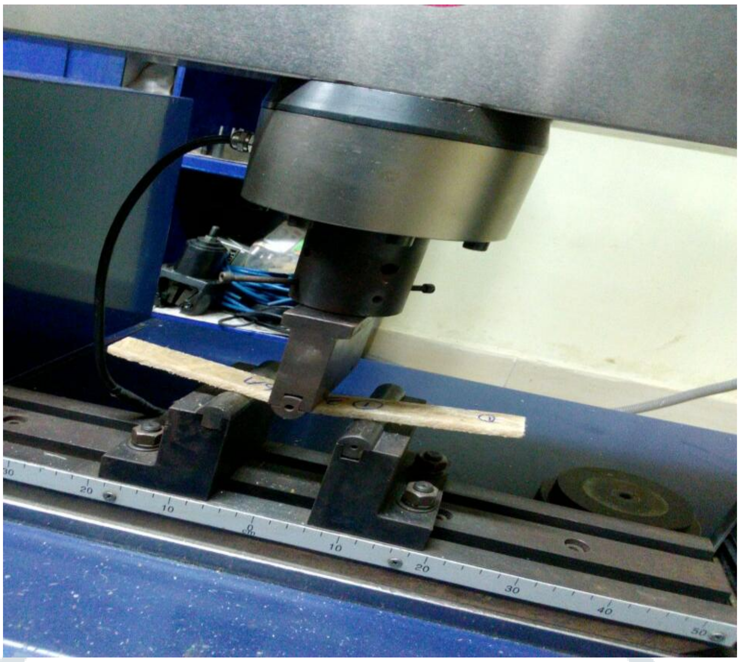

Fig. 8 flexural testing machine

C. ***Impact Test***

The impact test specimens are prepared according to the required dimension following the ASTM-A370 standard. During the testing process, the specimen must be loaded in the testing machine and allows the pendulum until it fractures or breaks. Using the charpoy impact test, the energy needed to break the material can be measured easily and can be used to measure the toughness of the material and the yield stress. Generally sisal fibers possess good impact absorbing properties. The fracture values were calculated by dividing the energy by cross sectional area of the specimen.

Fig. 8 Impact Testing machine

IV. RESULTS AND DISCUSSION

Table 4.1 Results for Tensile test

S No	Name of the Test	Materials	Sample 1	Sample 2	Sample 3	average
1	Tensile Strength (MPa)	B	5.12	4.10	3.14	**4.12**
		P	16.00	13.00	14.00	**14.34**
		H	11.00	13.00	12.00	**12.00**
		C	13.00	14.00	13.00	**13.34**

B: Three layer borassus fruit fiber

P: Three layer pineapple leaf fiber

H: Two layer borassus fruit fiber and one layer pineapple leaf fiber (Hybrid composite H)

C: Two layer pineapple leaf fiber and one layer borassus fruit fiber (Hybrid composite C)

The variation of Tensile strength of the laminate composite materials is shown in the above table. It exhibits the variations of Tensile strength with different composite specimens for the peak loads. The specimen composite**P** has high averagetensile strength of **14.34**MPa and the specimen**B**(3l Borassus Fruits Fiber) individual has low averageTensile strength of **4.12**MPa.The specimen hybrid composites**(H** and **C)**have average Tensile strengths **12.00**MPa and **13.34**MPa.

Table 4.2 Results for Flexural Test

S No	Name of the Test	Materials	Sample 1	Sample 2	Sample 3	average
2	Flexural Strength (MPa)	B	10.45	11.79	12.82	**11.69**
		P	37.88	34.87	36.20	**36.32**
		H	21.96	23.87	22.80	**22.88**
		C	52.20	48.08	46.08	**48.79**

B: Three layer borassus fruit fiber

P: Three layer pineapple leaf fiber

H: Two layer borassus fruit fiber and one layer pineapple leaf fiber (Hybrid composite H)

C: Two layer pineapple leaf fiber and one layer borassus fruit fiber(Hybrid composite C)

The variation of Flexural strength of the laminate composite materials is shown in the above table. It exhibits the variations of Flexural strength with different composite specimens for the peak loads. The specimen hybrid composite**C** has high averageFlexural strength of **48.79**Mpa and the specimen composite **B** has low Flexural strength of **11.69**MPa, **36.32**MPa forspecimen composite **P** and **22.88**Mpa for the hybrid composite H.

Table 4.3 Results for Impact Test

S No	Name of the Test	Materials	Sample 1	Sample 2	Sample 3	average
3	Energy (Joules)	B	04	04	04	**04**
		P	06	05	05	**5.33**
		H	06	06	06	**06**
		C	05	06	05	**5.33**

B: Three layer borassus fruit fiber

P: Three layer pineapple leaf fiber

H: Two layer borassus fruit fiber and one layer pineapple leaf fiber (Hybrid composite H)

C: Two layer pineapple leaf fiber and one layer borassus fruit fiber (Hybrid composite C)

The variation of Impact strength of the laminate composite materials is shown in the above table. It exhibits the variations of Impact strength with different composite specimens. The specimen composite**B** has low Impact strength of **4** J and the specimen hybrid composite has highImpact strength of **6** J and for specimen composite **P** and specimen hybrid composite **C** have average Impact strength **5.33**J.

V. CONCLUSION

From the experimental results are obtained, the following conclusion are given:

- The tensile strength of laminated composite **P** is **14.34**MPa greater than individual of borassus fruit fiber and hybrid composites **H** and **C**.
- Good tensile strength for hybrid composites **C**is **13.34**MPaand **H** is **12.00**MPa.
- The Flexural strength of hybrid composite**C**is **48.79**Mpagreater than individual of borassus fruit fiber,Pineapple leaf fiber and hybrid composite **H**.
- Good Flexural strength for laminated composite **P**is **36.32**Mpa.
- The Impact strength of Hybrid composite**H**is **6**J greater than individual of borassus Fruits fiber and,Pineapple leaf fiber and hybrid composite **C**.
- Good Impact strength for Pineapple leaf fiber and hybrid composite **C** is **5.33**J.

Hence the effect of borassus fruit fiber and Pineapple leaf fiber based laminate composite exhibit better Flexural strength and impact than individual laminate materials. These filled natural fibers composites has a wide range of applications such as in automobile industries as front and rear door liners, seat backs and sun roof interior shield, valence panels below front and rear bumper, electronic packages, in aircrafts as cabin and cargo hold furnishings, artificial limbs for physically handicapped, in oil industry and ducts for air condition.

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