Strength Analysis of Various Kinds of Composite Material By Experimentation

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Abstract— Composite materials are made of two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from individual components. In this research a natural fiber and hybrid composite which has two or more than two different reinforcement fibers inside the matrix. The interest in natural fibers was generated due to the high material, processing cost, toxicity and specific gravity of the synthetic fibers. In this research the Areca nut coir, Coconut coir & Baggase fibers are extracted by water retting and mechanical method. The fibers are treated with alkali solution (NaOH). Then the glass mould of dimension 200×150×3mm is prepared. Fabrication is done by hand lay-up method. Fabrication is carried out for different composition of natural fiber and synthetic fiber (glass) by reinforcing in epoxy matrix. The tests were carried out according to the ASTM standards to determine mechanical properties of the fabricated specimens.

Key words: Areca coir, Coco-nut coir, Baggase fiber, Epoxy resin, Tensile test, Flexural test, Impact test

I. INTRODUCTION

Composites have been used throughout the history, i.e., straw in bricks, metal rod-reinforced concrete and light weight aerospace structures. Fiber reinforced polymer matrix composite materials are being introduced in ever-increasing quantities in military systems and have become a main element in the department of Defense's effort to lighten the force. However, polymer matrix composites have an intrinsic temperature limitations based on their hydrocarbon structure.

A composite is defined as a material containing two or more separate phases combined in such a way so that each remains distinct. For several centuries, metals have been the preferred engineering materials for the design and manufacture of components. Metals and alloys like steel, copper, aluminum, zinc, brass, bronze etc., find extensive use in all walks of life.

Composite materials, particularly fiber reinforced polymeric composites (FRPCs) are an extremely broad and versatile class of material system for automotive, aerospace and marine applications due to the possibility of high strength and modulus coupled with light weight, design and fabrication flexibility and improved mechanical performance. The commonly used filled-fiber-reinforcement in polymer composites are glass, carbon and Aramid (Kelvar 49). These composites made of such materials not only retain high strength, stiffness and thermal resistance but also show enhanced impact strength, fatigue resistance and dimensional stability. One of the well-known composite that is commonly used is glass fiber reinforced polymeric (GFRP) material. Glass fibers have good mechanical properties at very reasonable cost when compared to carbons. The purpose of fiber reinforced polymers (FRP) composite matrix material is to bind the fibers together.

Automotive, aircraft and marine components fabricated with FRPCs have tight requirements in service and they can withstand mechanical damages during service. The fiber damage could occur during fabrication process, storage, service, transport and maintenance. They are susceptible to mechanical damages when they are subjected to effects of tension, compression and flexure, which can lead to inter layer delamination. So, the hybrid polymer can be effectively used to overcome those limitations.

B.D. Bachtiar, S.M. Sapuan and M.M. Hamdan (2010) [1]: The hybridization of the reinforcement in the composite shows greater flexural strength when compared to individual type of natural fibers reinforced composites. In order to achieve high strength and less weight, it requires combining two or more distinct materials to get composite materials. They are environmentally friendly, fully biodegradable, abundantly available, and renewable. This good environmental friendly feature makes the materials very popular in engineering markets such as the automotive and construction industry.

Govardhan Goud and R N Rao (2011)[2]: Natural fiber composites are not only biodegradable and renewable but also possess several other advantages such as lightweight, low cost, high specific strength, high modulus, reduced tool wear and safe manufacturing process when compared with synthetic fiber composites. Several applications of natural fiber composites can be found in construction, packaging, furniture and automotive fields. Most of the interiors of the automobiles, like door panels, trunk liners, seal backs, packages, speaker trays, engine and transmission covers, are made using natural fiber composites. The greatest challenge in using the natural fiber as reinforcement in polymer matrix is the poor adhesion between natural fiber and matrix. This results in inferior strength of the composites. The main reason for the poor compatibility is that while polymer matrix is hydrophobic and non-polar, the natural fibers are hydrophilic and have polar groups in their structure. Moreover, natural fibers also consist of several elementary fibers associated with cellulose, hemicelluloses, pectin, lignin, etc. Hence, they cannot be considered as the mono-filament fibers. To remove the unwanted elements from the fiber, specific treatments are necessary. Many investigators found and reported that the interfacial bonding can be enhanced by the surface modification of the fiber through alkali treatment and treatment with coupling agents, which in turn will enhance the overall performance of the composites.

II. MATERIAL AND METHODOLOGY

1) Material: Areca nut fibers are extracted from Areca nut fruits husk. Coco nut fibers extracted from the coco nuts husk. The bagasse is the by-product of sugar cane waste.

Bagasse fibers are extracted from the sugar cane waste. Hardner HY951 and Epoxy LY556 was purchased from Arg industries ,Pune India.

2) Fiber extraction: Initially survey of Areca nut & Coconut plant is done. Then, the husk of plant is collected in huge quantity from Datta Sugar Mill Nursery, Shirol. Then the collected husk & Bagasse are dried under sunlight for 2-3 days. After drying then dipped in water for 2-3 hours. Dipped coir is taken out and fiber is extracted by retting method.
3) Alkali Treatment: Initially some amount of Areca nut, Coconut coir & Baggase fiber is washed with water. Then it is treated with 5% concentrated alkali solution to check the optimization strength for every half hour up to 6 hours. Then strength of the treated fibers are checked manually and decided that for 1 hour treated fiber gives optimum strength. Before soaking it with alkali the weight of the collected fibers were 80gms. Then whole amount of fiber is soaked in NaOH solution for 1 hour. After 1 hour soaking the fiber is taken out and thoroughly washed with water. Then after drying for 24 hours the weight of the fibre was noted as 60gms. The total yield of the fibre after alkali treatment is found to be increased. The alkali treatment improves the adhesive characteristics of fiber surface by removing hemicelluloses and lignin [6].

Fig. 1: Alkali treated Areca fiber

Fig. 2: Alkali treated Bagasse fiber

Fig. 3: Alkali treated Coco-nut fiber

4) Glass Mould Preparation: Prepare the glass mould of 200x150x3mm with the help of spacers. Apply the Teflon cloth on the prepared glass mould. Fig 5. shows prepared glass mould. The moulds are prepared with varying weight of glass fiber and natural fibers (Areaca nut coir, Coco nut coir, Baggase).

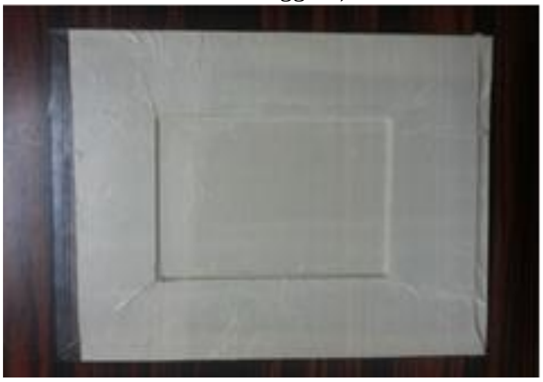

Fig. 4: Prepared Glass Mould

5) Manufacturing Technique Hand lay-up Method:

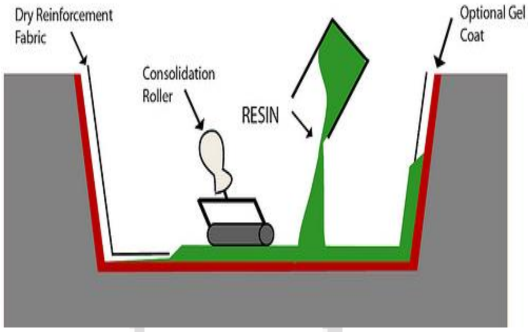

Fig. 5: Hand lay-Up method

The most popular type of open molding is hand lay-up process it is shown in the fig.5. It is a simple but effective process which takes relatively low capital investment but high labour cost. Hand lay-up process is fabrication process to manufacture of fibre reinforced polymer (FRP) products. It is simple but effective process and it is cheap process as compared to other processes. Mold is taken which is made of glass and its surface should be covered with Teflon sheet. Then resin and a thin layer of reinforcement are placed. After curing the component is pulled out of the mould. The prepared mould as shown in the fig.6.

Fig. 6: Fabricated plates

III. Testing of Components:

Table 1 shows the test results, test which is carried out according to ASTM standard

Sr no	Specimen	Tensile Test(MPa)	Flexural Test(MPa)	Impact Test(J/m))
1	Areca nut Fibers	12.44	25.62	45.53

2	Areca nut Fibers & Glass Fibers	12.98	44.67	105.4
3	Coco-nut Fibers	6.79	26.75	49.66
4	Coco-nut Fibers & Glass Fibers	16.26	56.74	74.93
5	Bagasse Fibers	8.48	28.23	52.76
6	Bagasse Fibers & Glass Fibers	15.38	51.11	71.96

Table 1: Results of components

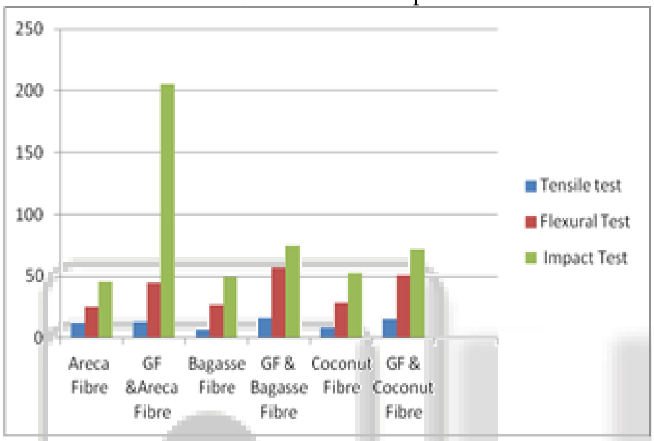

Fig. 7: Results of mechanical test

IV. Conclusion

The mechanical properties of Areca nut fiber, Coco-nut fiber and Bagasse fiber are determined by using experimental method. The epoxy resin and natural fibers were mixing together to make the composite plates. The research focuses on mechanical properties of Areca nut fiber, Coco-nut fiber and Bagaase fiber. The tests were carried out according to the ASTM standards. The experimental results compared within the natural fiber and hybrid fiber composite. In tensile test and Flexural test the Coco-nut hybrid fiber have 16.26 Mpa and 56.74 Mpa. In Impact test Areca nut hybrid fiber have 105.4 J/m. From the experimental results there is increase in the strength of material by using the glass fiber.

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