FABRICATION AND STUDY OF MECHANICAL PROPERTIES OF HYBRID COMPOSITE MATERIAL USING SIDA ACUTA PLANT FIBER AND VINYL ESTER RESIN

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Abstract:

Last few decades have seen composite materials being used predominantly in various applications. Many type of natural fiber have been investigated for their use in plastic including jute, wood fiber, rice husk, cane, grass reeds, coir. Their number of application have grown steadily. Natural fibers are alternate resources to synthetic fiber. Natural fibers are cheap and renewable .In this project work mechanical properties are studied of the composite material which is reinforced by fibers extracted from SIDA ACUTA plant and vinyl ester resin is used. The natural fiber is extracted by tank retting process. To improve the mechanical properties SIDA ACUTA fiber is hybridized with carbon fiber. The composite was made by hand lay-up method which is economic and easy process for making composite material. The mechanical property like impact strength, hardness test were carried out on composite specimens to find out its sustainability. Their strength were compared with composite made up of jute fiber. Also the water absorption capacity recorded

Key words: *Hand lay-up method, SIDA ACUTA, Tank retting method, Impact strength, Hardness, Water absorption capacity*

INTRODUCTION

Composites are materials that comprises strong load carrying material (known as reinforcement) imbedded in weaker material (known as matrix). Reinforcements provide strength and rigidity. Matrix or binder maintains the position orientation of the reinforcement and transfer the load to the reinforcement. Composites, also known as Fiber-Reinforced Polymer (FRP) composites, are made from a carbon or aramid) or other reinforcing material. The matrix protects the fibers from environmental and external damage and transfers the load between the fibers. The fibers, in turn, provide strength and stiffness to reinforce the matrix—and help it resist cracks and fractures. Composite materials include some of the most advanced engineering materials today. The addition of high strength fibers to a polymer matrix can greatly improve mechanical properties such as ultimate tensile strength, flexural modulus, and temperature resistance.

Bio-composite is a composite material formed by a matrix (resin) and a reinforcement of natural fiber. These kind of materials often mimic the structure of the living materials involved the process keeping the strengthen properties of the matrix that was used, but always providing biocompatibility. Natural fibers are extracted from different parts of the plants.

Natural Fibers also classified according to their morphological structure such as Bast fiber,Leaf fiber and seed fiber.

Classification of composite materials:

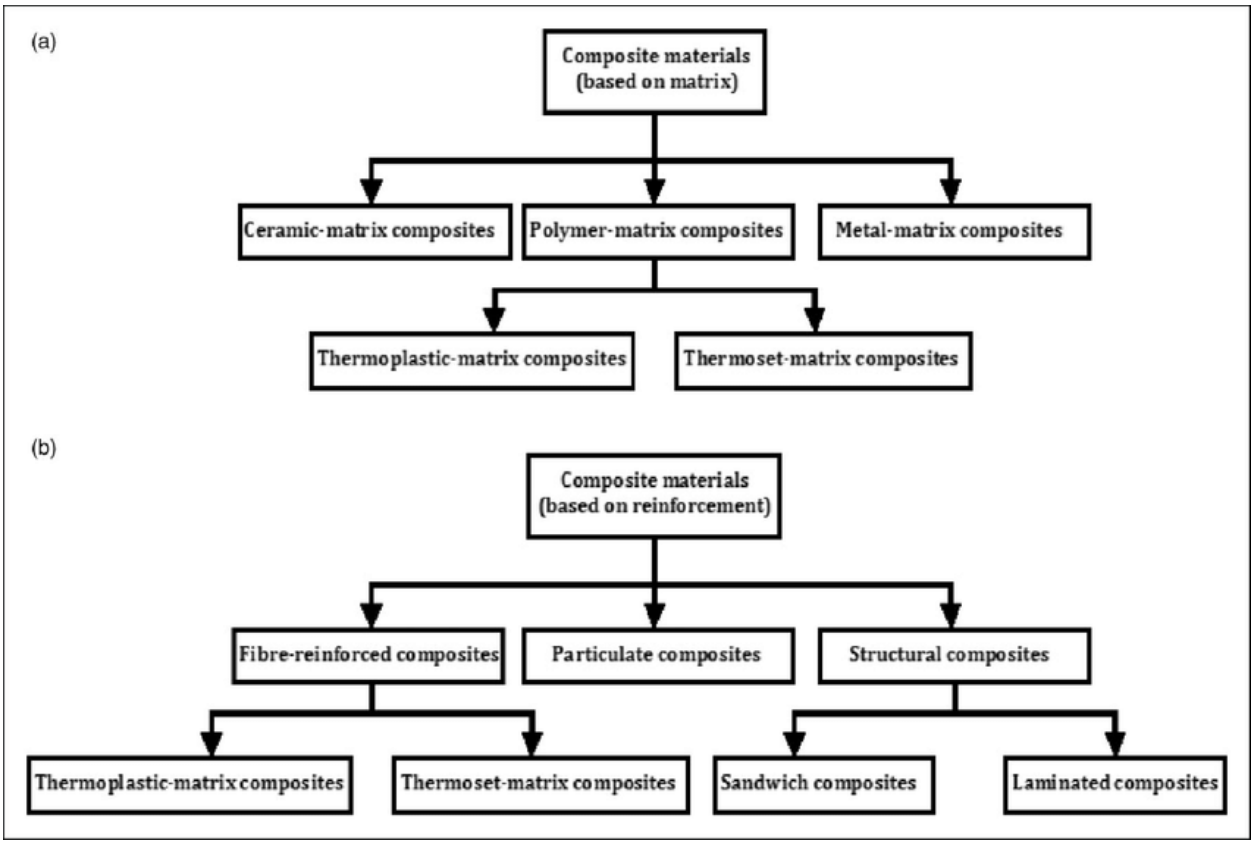


Fig.1

[(a) - Based on matrix, (b)- Based on reinforcement]

M. Mahesh et al.[1] made composites from elephant-grass and glass fiber.. Elephant grass or grass fiber reinforced polyester hybrid composites are prepared by using different mass ratio & observed that (40/0%) only mass of fiber compare with (30/10%) of hybrid composites. Increasing the percentage of natural fiber to the glass fiber content increase the tensile strength, tensile modulus, flexural strength, flexural modulus, impact strength respectively. Fish scale and Vinyl ester as resin and using hand lay-up and compression molding techniques a composite material is prepared by V. Gopi et al.[2]. The tensile strength is increased 10wt% by fish scale, flexural strength and hardness is also increased.

Sharma et al. [3] prepared composite using different composition of rice husk and poly propylene. The composite which contained 70%polypropylene + 30% rice husk with talc powder gave excellent result. In density test the specimen containing 80%polypropylene + 20% rice husk and calcium carbonate gave best result. Kumar et al. [4] developed a composite by the help of jute fiber and polypropylene. Jute fiber is used as reinforce material. By following hot compression method they created three specimens of different composition of jute fiber i.e. 30%,

40%and 50%. They suggested that in a composite 40% is optimum of jute fiber for enforcing polypropylene matrix.

Spinifex grass fiber used as reinforcing phase in thermoplastic polyurethane prepared from spinifex resin biopolymer with fiber content 20%, 30%, 40% and 50% Mondal et al. [5]. With the increase in fiber content in composite, the Young's modulus and Tensile stress increased to several fold. Binhussain et al. [6] developed a composite using 1:1 ratio of palm leaves and plastic waste, were designed and developed namely, polycarbonate (PC-mix), polystyrene (PS-mix) and polyvinyl chloride(PVC-mix). The density, water absorption, hardness, modulus of elasticity (tensile and flexural), impact strength, linear burning were tested with different samples. Those test results were compared with natural hard, soft wood and medium density fiberboard woods. They suggested that PS-mix composites are less dense compared to PC and PVC mix composites. The mean hardness of PC-mix, PV-mix and PS- mix were less than natural wood and MDF. The PVC- and PS-mix exhibited a higher strength and modulus and lower breaking strain than PC-mix. The rate of linear burning higher for natural wood and MDF than PC-, PVC-, PS-mix.

The combination of sisal and papaya with glass fiber hybrid composites and combination of natural fiber with synthetic fibers decreases the maximum absorption and increase the mechanical properties of composites. Martin et al. [7]. Vinyl ester, polypropylene, and epoxy resin were reinforced with several natural fibers just like jute fiber, fish scale, papaya stem fiber, palm leaf etc. But none of them are not economic and not used widely. So in this research work natural fiber extracted from SIDA ACUTA plant and hybridized with carbon fiber. Vinyl ester is taken as the resin. The main objective of this research is to Extraction of fibers from SIDA ACUTA and Prepare a composite using SIDA ACUTA plant fiber, vinyl ester, and carbon fiber. Studies of mechanical properties like impact strength, hardness and water absorption capacity.

Materials and Experimental Procedures

Vinyl ester refers to esters formerly derived from vinyl alcohol is taken as resin. Vinyl esters are more tolerant of stretching than polyesters. This makes them more able to absorb impact without damage. They are also likely to show stress crackling. Vinyl ester has fewer open sites in its molecular chain. This makes it much more resistant to water penetration. Sida acuta commonly named as "Bheemanakaddi Gida" contain high amount of fiber in its stem so to rein force vinyl ester sida acuta plant fiber and carbon fiber was selected.

Natural fiber extracted from sida acuta plant stem using tank retting process. Tank retting method, increasingly important method, allows greater control and produces more uniform quality. This process, usually employing concrete vats, requires about four to six days. In the first 6 to 8 hours, called the leaching period, much of the dirt and coloring matter is removed by water. The retted stalks, called straw, are dried in open air or by mechanical means and are frequently stored for a short period to allowed curing to occur, facilitating fiber removal. Final separation of the fiber is accomplished by breaking or scrapping of dried straws

(a)

(c)

(b)

(d)

[Fig 2. a. vinyl ester and hardener, b. Sida acuta stem, c. Sida acuta plant, d. Granular carbon fiber]

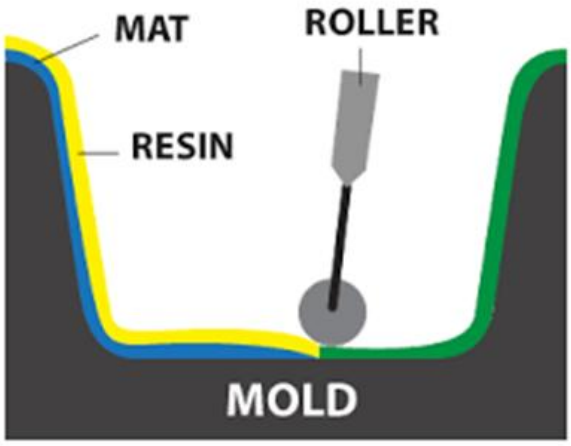
The weight percentage of carbon fiber is taken more than natural fiber. Two samples were made using hand lay-up method. The compositions were taken same for both of the samples. Hand lay-up is the most common and least expensive open-molding method because it requires the least amount of equipment. Fiber reinforcements are placed by hand in a mold and resin is applied with a brush or roller. This process is used to make both large and small items

[Fig 3. fiber extracted by tank retting process]

[Fig 4. extracted sida acuta fiber]

To prepare the composite use hand lay-up method a mold which is of ply wood and flat type were prepared. Upon the ply wood we placed the lamination film so that after the preparation of composite it would not stick to the ply as well as it would be removed easily. For 1st specimen the carbon fiber is mixed with the resin and hardener a glass container properly and placed on the

lamination film and by the help of a metal sheet piece the mixed carbon is equally distributed upon the plywood. After distributing the carbon fiber, the plant fiber is placed at 0^0 with carbon fiber. After preparing the 2nd layer again mixed carbon fiber are equally distributed on the plant fiber. After the 3rd layer again the plant fiber is placed 90^0 with the carbon fiber. After the 4th layer the carbon fiber is placed and after the 5th layer the plant fiber are placed on the carbon fiber which making 0^0 with the carbon fiber. Then by lamination film it covered, the layer is pressed with a roller bar to remove the air gap. After rolling another ply will be placed upon it and some load is placed upon the ply wood. After 24 hour weight was removed and the mold was opened to get the composite. The same procedure was followed to make the 2nd specimen but it slightly differ from the 1st specimen that is the layer of both carbon fiber and plant fiber are sandwiched. After 24 hour the 2nd specimen were removed from the mold. After preparing the both of the sample, it was cut by the cutter for different testing.



[Fig 5. hand lay-up method]

[Fig 6. prepared composite material]

Sample No	Percentage of Carbon Fiber	Percentage of Natural Fiber	Percentage of Vinyl Ester and Hardener(5:1)
1	20%=80gm	10%=40gm	70%=280gm, Hardener-46.66gm, V.E.-233.33gm

[Table no 1. Composition of material]

RESULT AND DISCUSSION

After successfully fabrication of composite material different mechanical test were conducted on it. Charpy test, Izod impact strength, Rockwell hardness, water absorption test were performed by cutting the fabricated composite to different desired specimen size.

Charpy Test

Charpy impact test was done on charpy test bed. The specimen for charpy impact test was taken 10mm x 10mm x55mm.Total three samples were taken for charpy test and the average value for charpy impact test were taken 60 KJ/m^2.

Experiment No	Impact strength KJ/m^2
1	62
2	58
3	60

[Table no 2. Charpy test results]

Izod Impact Strength

Izod impact strength also studied by taking three samples of the composite. The specimen for Izod was taken 10mm x 10mm x 75mm. the specimen were placed vertically on the test bed. From the experiments the average value for Izod impact test were taken 8KJ/m^2.

Experiment No	Izod impact strength KJ/m^2
1	8
2	8
3	8

[Table no 3. Izod test result]

[Fig 7. Specimen after charpy test]

[Fig 8. Specimen after Izod test]

Hardness

Rockwell hardness test were done. 1/16 inch ball indenter was used to get the hardness value. Three times hardness were tested. The average Rockwell hardness value is 11.66

Sample No	Hardness Value
1	10
2	12
3	13

[Table no 4. Hardness Values]

Water Absorption Test

Specimen of 30mm x10 mm of two samples were prepared. Those sample were weighted to get their weight in dry state. Then the samples were kept for 48 hour. Then then after 48 hour the weight of both samples were recorded.

Sample No	Weight before water absorb(w_0)	Weight after water absorbed (w_t)	Weight difference between w_0 and w_t in percentage
1	1.6233gm	1.7084gm	5.24%
2	2.5150gm	2.6663gm	6.01%

[Table no 5.water absorption test results]

The percentage water absorbed by the composites was calculated using the equation

$$W\ (\%) = [w_t - w_o / w_o] * 100$$

w_t- final weight w_o- weight before deeping in water

Mechanical strength like impact and harness were studied and water absorption capacity also recorded. From charpy impact strength average value was 60 KJ/m^2, which is more than composites made using rice husk, jute fiber and fish scale as reinforcement material. The average Rockwell hardness value is 11.66.

Conclusion

In this research work experimental investigation has been done. In present study polymer matrix composite with Sida Acuta fiber which was extracted from Sida Acuta stem using tank retting method and carbon fiber used as filler material and vinyl ester was used as basic material. The composite was made with help of hand lay-up method.

The mechanical properties of jute/polymer, rice husk/polymer, fish scale/polymer do not possess strengths as high as Sida Acuta + carbon fiber/vinyl ester composite. The average impact test of charpy is 60KJ/m^2 and for izod is 8 KJ/m^2.the average Rockwell hardness is 11.6. Therefore, this composite could be used for future use. Since the reinforcing material is eco-friendly, non-toxic, non-toxic, non-health hazardous, easily available. To strengthen the natural fiber carbon fiber was used as synthetic fiber. The water absorption capacity varies 5%-6%, so it can be used in different places.

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