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Fabrication and mechanical properties of natural (coconut) & synthetic fibers (glass fibers) reinforced polymer composites material

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ABSTRACT

The duty of manufacture engineering is to bring the ideas into reality by proper selection of material, and manufacturing process. Among this three the selection of material is first one.

Different types of material required for the different types of applications. In present days manufacturing demands, high rate of accuracy, good quality and high strength per minimum weight and same as the aircraft engines are searching for the materials that have low density and strong, stiff and abrasive and impact resistance this can be achieved by the composite material.

A composite material is a multi phase material that is artificial made as opposed to one that occurs or forms naturally. Composite material exhibits a significant proportion of the both constituent phases such that a better combination of properties is realized.

In this paper, we have chosen glass fiber and coconut fibers as reinforced in composite materials. During manufacturing we took the fibers in random orientation. The composite materials are fabricated by varying of weights of the fibers.

And we conducted two types of tests, which are tensile test and flexural tests and finally we got the positive results from the plotting of different graphs in between different variable, we compare the results with each other from the glass fiber having the good strength among those fibers.

KEY WORDS
Composites, Coconut, Fabrication, Natural Fibre.

1 INTRODUCTION

A composite material is a combination of at least two chemically distinct materials with a distinct interface separating the components. Composite is any material made of more than one component. There are a lot of composites. Concrete is a composite. It's made of cement, gravel, and sand, and often has steel rods inside to reinforce it.

Historically, technical developments have cantered around two main areas, firstly the development of more powerful and efficiently energy sources and secondly to obtain maximum possible motive power from the available energy. The second development is heavily dependent on the properties of engineering materials [1, 2]. In aircraft and aerospace industries, a union of opposites i.e., lightweight in combination with high stiffness is demanded. In pressure vessels technology, high strength and corrosion resistance are both prerequisites for efficient operation. Whenever, a designer faces such situations composite materials provide an efficient solution to such problems. The flexibility that can be achieved with composite materials is immense. Merely by changing the composition variety of properties can be altered thus making the composites versatile and reliable substitutes for the conventional structural materials.

2 MATERIALS

2.1 Matrix phase

The matrix phase is FRP may be achieved by

- Polyester resins
- Epoxies
- Phenolics
- Silicones
- Nylon

For ordinary applications polyester resins are employed. Epoxies are suggested only for special applications, as they are costly.

2.2. Reinforcement

The various materials that can be employed to reinforce the matrix phase in FRP are:

- Natural Fibers
- Synthetic fibers

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Under natural fibers:

- Coconut fibers (coir fibers)
- Bamboo fibers
- Jute fibers
- Pineapple fibers

Under synthetic fibers:

- Glass fibers
- Boron
- Carbon
- Silicon fibers

3 HAND LAY UP MOULDING PROCESS

When the operator deposits resin and reinforcements in a mould by hand or hand tools, he is said to be making a hand lay-up molding.
The different layers of reinforcement thoroughly wetted with resin are placed one over the other to build up the desired thickness shown in fig 1. Hand lay-up [3] may be chosen as the fabrication technique when

1. Only one side of the product needs smooth finish
2. Only slight variations in thickness are permissible.
3. Only when labour charges are not prohibitively high
4. The number of moldings required is small.

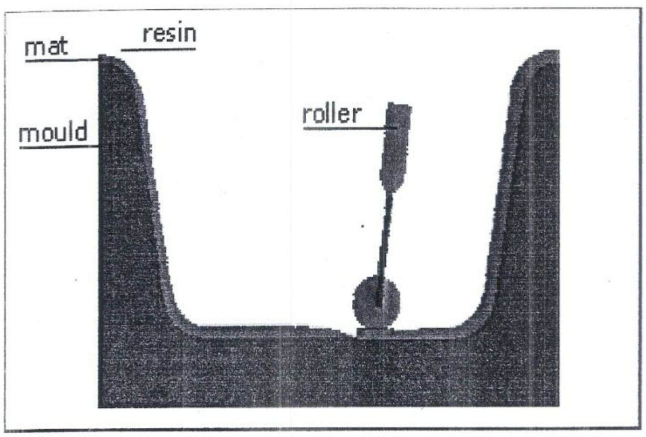

Figure 1. Hand layup process

The mould employed to obtain tile molding may be made from materials like plastics, wood, clay, plaster or plywood depending on the availability. To prevent the sticking of the plastic to the mould-releasing agent like cellulose acetate, polyvinyl alcohol or candle waxes are applied.

Hand lay-up moulding may be used for the production of parts of any dimensions, for example, technical parts of a few tens of m2 area, as well as swimming pools of 150 m2 developed area. But, this method is generally limited to the manufacture of parts with relatively simple shapes, requiring only one face to have a smooth appearance (the other face being rough from the moulding operation). It is recommended for small and medium volumes, for which the investment in moulds and equipment should not be very high.

A coating of resin is made on the mould surface. Again a coating of resin is applied with the help of a brush. This process is continued to build up the required thickness. The mould may then be cured either in atmosphere or in an oven to enhance the curing rate. The product may then be ejected.

3.1 Advantages

- The process is simple and requires no costly machinery.
- There is practically no restriction on the size of the mould.
- The process is highly flexible and can be modified to cater to customer's choice.

3.2 Disadvantages

- This process is labour-intensive and hence the associated labour costs are higher.
- It is not suitable for mass production.

3.3 Applications

Boats
Briefcases
Sanitary ware
Safety helmets
Automotive components

4 EXPERIMENTAL WORK

We chosen hand layup method for fabrication.

In the present work polyester resin, accelerator (cobalt napthenate), catalyst (methyl ethyl ketone peroxide) and styrene monomer (after removing the inhibitor) were used as matrix components.

The Sisal plant has a 7-10 year life-span and typically produces 200-250 commercially usable leaves. Each leaf contains an average of around 1000 fibres. The fibre element, which accounts for only about 4% of the plant by weight, is extracted by a process known as decortication.

- The matrix material used in this investigation was bio epoxy resin Grade D638 and Hardner 3554D. Supplied by Janki Enterprises, Chennai.
- Sisal fibres have been used traditionally in high strength ropes in India especially in South India regions.

1. ACCELERATOR A material which, when mixed with a catalyzed resin, will speed up the chemical reaction between the catalyst and the resin. Also known as "promoter".

2. CATALYST A substance which changes the rate of a chemical reaction without itself undergoing permanent change in its composition; a [6,7] substance which markedly speeds up the cure of a compound when added in minor quantity compared to the amounts of primary reactants (hardener, initiator or curing agent).

3. POLYESTER Thermosetting resins, produced by dissolving unsaturated, generally linear, alkyd resins in a vinyl-type active monomer such as styrene, methyl styrene and diallyl phthalate. The resins are usually furnished in solution form, but powdered solids are also available.

Glass fibers (synthetic fibers) and coconut fibers (natural fibers) were used as reinforcement. The density of polyester resin is 0.909 gm/cc. The chemical formula for styrene is C_8H_8.

4.1 Preparation of mould and sample plates

For making the test specimen different sample plates were prepared for tensile test, flexural test and density, of the glass mould of dimensions 180 * 180 * 4mm thick plates were cut and a mould cavity of 160 * 160 * 4mm is made by fixing 4mm [4] thick glass plates of width 15mm and thickness 4mm on four sides of the plate using araldite. The mould was cured in the furnace at temperature of 50°C for about 15 hours and for making sample plates in each test the bottom and sidewalls of the mould were alternately coated with aqueous solution of poly vinyl alcohol (PVA) and hard wax.

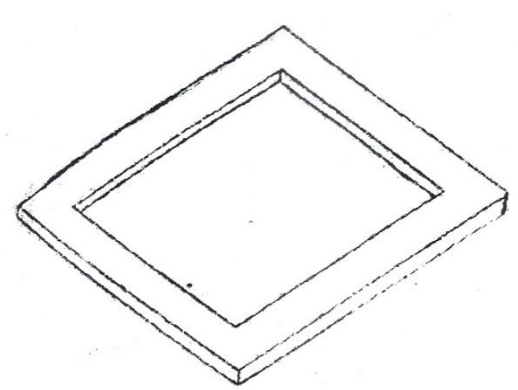

Figure 2. Pattern

The unsaturated polyester resin and styrene were mixed in the ratio of 100 and 25 parts by volume respectively. Later to this 0.5 parts each of accelerator and catalyst were added to the mixture.

The glass fibers and coconut fibers were cut into required size and weighed accurately in each case. The sample plates prepared by varying the weight fraction of fibers. The composite is prepared by curing this system and the sample plates were cut into required size as per ASTM Standards.

4.2 Procedure for casting a composite

- Collect 25 ml of styrene (purified) in a beaker and add 0.5 ml of accelerator and catalyst in a funnel.
- Stir the mixture gently avoiding bubble formation.
- Polyster resin of 100 ml should be added to the mixture and stir the matrix well.
- Clean the cavity and apply wax by levelling it with spirit level.
- Pour the matrix in the cavity to form a layer of around half of the cavity.
- Disperse the fibers randomly in the matrix surface.
- Fill the remaining cavity with the matrix.
- Allow this for the following stages.

4.3 TENSION TEST USING UTM

Fabricated composite was cut to get the desired dimension of specimen for mechanical testing. Tensile strength was tested in UTM machine.

Figure.4 Universal Testing Machine

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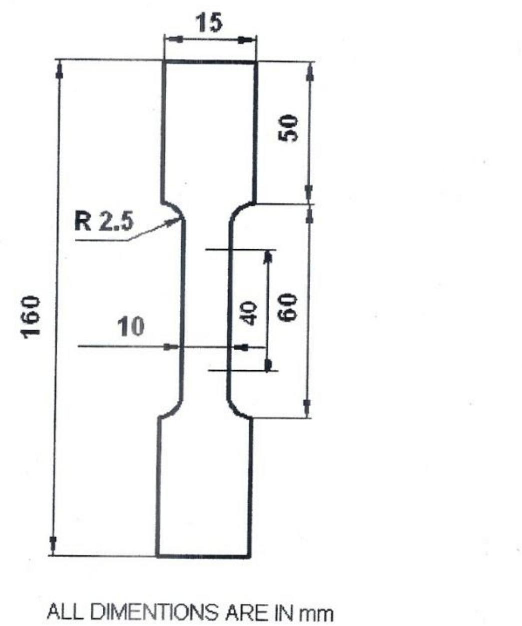

Figure 4.Specimen for Tensile Test as per ASTM standards

4.4 Flexural test on simply supported beam

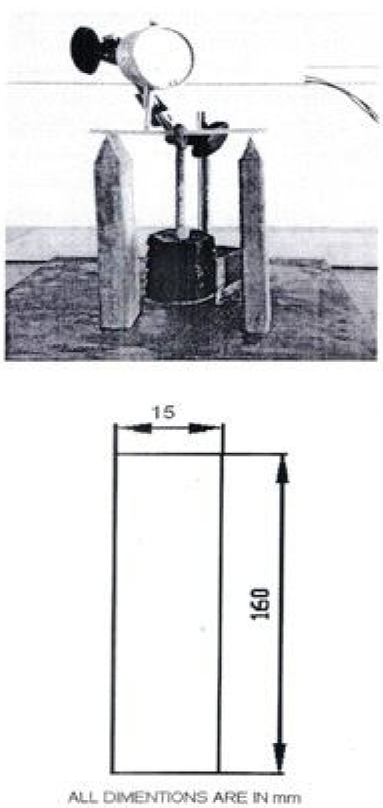

Figure 5. Specimen for flexural test

4.3 Tension & flexural test results:

<u>VARATION OF TENSILE STRENGTH WITH % WEIGHT FRACTION OF GLASS FIBER REINFORCED POLYESTER COMPOSITES</u>

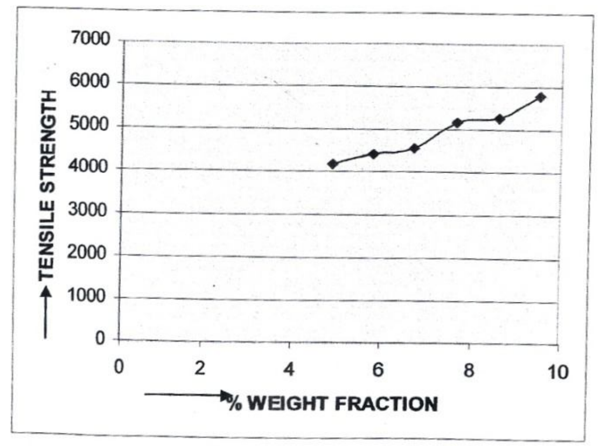

Figure 6. Tensile Strength vs weight fraction

<u>VARATION OF TENSILE STRENGTH WITH % WEIGHT FRACTION OF COCONUT FIBER REINFORCED POLYESTER COMPOSITES [5]</u>

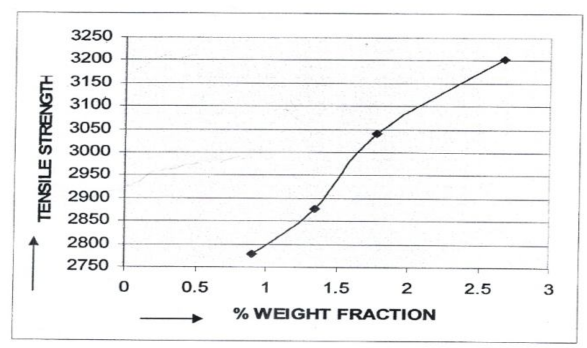

Figure 7. Tensile strength vs weight fraction

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VARATION OF YOUNG'S MODULUS WITH % WEIGHT FRACTION OF GLASS FIBER REINFORCED POLYESTER COMPOSITES

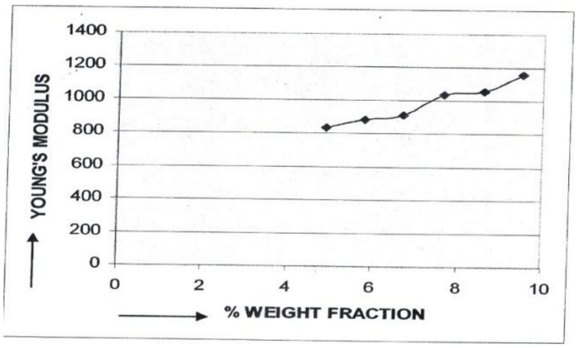

Figure 8. Young's modulus vs weight fraction

VARATION OF YOUNG'S MODULUS WITH % WEIGHT FRACTION OF COCONUT FIBER REINFORCED POLYESTER COMPOSITES

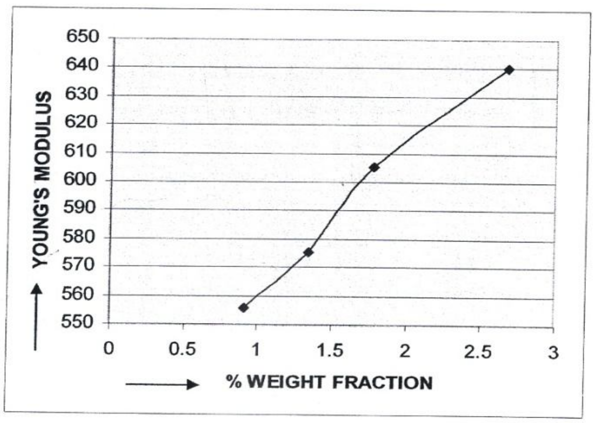

Figure 9. Young's modulus vs weight fraction

VARATION OF STIFFNESS WITH % WEIGHT FRACTION OF GLASS FIBER REINFORCED POLYESTER COMPOSITES.

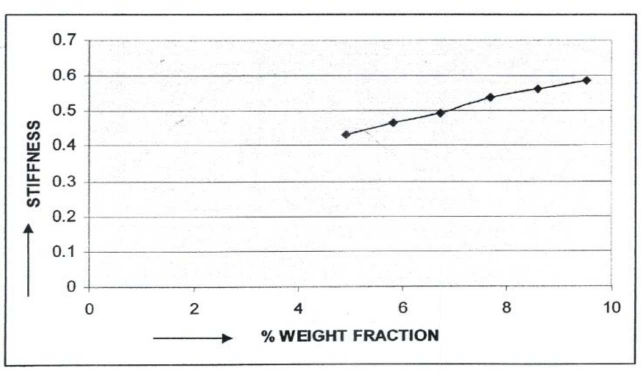

Figure 10. Stiffness vs weight fraction

VARATION OF STIFFNESS WITH % FRACTION OF COCONUT FIBER REINFORCED POLYESTER COMPOSITES.

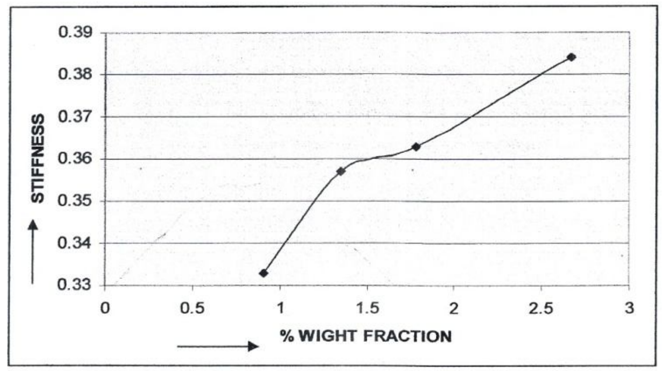

Figure 11.Stiffness vs weight fraction

5 CONCLUSIONS

- The average load a break increases substantially with the increase in percentage weight fraction of fibers.
- The average braking load of coconut fiber reinforced plastics is slightly less than the glass fiber reinforced plastic, when the % of fiber increased.
- For getting same strength as compared to the mild steel the % of glass fiber should increased up to 50 to 60% by volume, the % of coconut fiber should be increase 70 to 80% by volume.
- From the graph drawn between the Stiffness and the Weight fraction of fiber, it is found that as the quantity of fibers is increasing the stiffness value of composite may reach the stiffness value of fiber.
- Coconut fiber is a natural fiber, the manufacturing cost as compared to glass fiber is very less, and the strength of coconut fiber is approximately 25% less.

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