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ANALYSIS OF POLYMER MATRIX COMPOSITE MATERIAL USINGNATURAL AND SYNTHETIC FIBRE

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ABSTRACT
Sustainable development and other concern about the save of energy incite many companies, especially in the field of transport, to use composite. These offer a non-negligible gain of weight while respecting the reliability and security requirement of the manufacturer. The obvious composite solutions are the thermoset polymer reinforced with glass or carbon fibre, thanks to their low cost or high performance. However, these composites have some disadvantages in particular in term of recycling or revalorizing. Today, an alternative appears with the growth of composite reinforced with natural fibres and thermoset matrix. These offer mechanical properties close to glass fibre with a positive carbon assessment. Moreover many solutions were developed these previous years to separate the fibres from the thermoset matrix, permitting a revalorization of the waste. The aim of this project is to study a new composite made of an polymer matrix reinforced with synthetic (glass) fibre and natural (sisal & pineapple) fibre. Several mechanical tests, in static and dynamic load, are performed to validate its use as a structural or semi-structural material.

KEYWORDS: polymer composites, natural fibers, synthetic fibers, mechanical strength, properties

INTRODUCTION
A composite material consists of two or more materials, which are macroscopically combined to produce desirable properties that can be achieved with any of the individual constituents. Composite material may be classified as follows:

1. Fibrous composites, have continuous or discontinuous or whiskers in matrix. Examples are wood, bone, plastics reinforce with Kevlar fibre, carbon fibre, glass fibre and metal reinforced with boron fibre.
2. Laminated composites, as layers of solids (such as clad metals, laminated glass plastic-impregnated cloths and paper, laminated fibrous composites)
3. Particulate composites, has particles in the matrix. Examples are concrete (gravels in the mortar), carbon black, silicon carbide etc.

Composite materials are formed by combining two or more materials that have quite different properties. The different materials work together to give the composite unique properties, but within the composite. You can easily tell the different materials apart they do not dissolve or blend into each other. Composite exists in nature. A piece of wood is a composite, with long fibres of cellulose (a very complex form of starch) held together by a much weaker substance called lignin. Cellulose is also found in cotton and linen but it is the binding power of lignin that makes a piece of timber much stronger than a bundle of cotton fibre.

The properties that can be improved by a composite material include

a) Strength
b) Stiffness
c) Corrosion resistance
d) Less weight
e) Attractiveness

In principle, any two materials could be combined to make a composite and they might be mixed in many geometries.

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Benefits Of Composites

Different materials are suited for different applications. When Composite are selected over traditional materials such as metal alloys or woods, it is usually because of one or more of the following advantages.

Cost

i. Prototypes
ii. Mass Production
iii. Part consolidation
iv. Maintenance
v. Long term surface
vi. Production time
vii. Maturity of technology

Weight

1. Light weight
2. Weight distribution

Strength and stiffness

1. High strength to weight ratio
2. Directional strength and or stiffness

Surface properties

1. Corrosion resistance
2. Weather resistance
3. Tailored surface finish

LITERATURE

Navdeep Malhotra et al.(2012) proposed that natural fibers have been used to reinforcing materials for over 2,000 years. The necessity for renewable fiber reinforced composites has not been as prevalent as it currently is. Natural fibers are emerging as cost effective and apparently ecologically superior substitutes to glass fibers in composites. In this review a comparative life cycle valuation of Natural fiber reinforced polymer matrix composite materials has been accounted. The methodology and findings of mechanical and fracture surface characterization of various natural fiber composites has been summarized.

Sakthivel and Ramesh (2010) studied that natural fibres was used to reinforce materials they have been employed in combination with plastics. Many types of natural fibres have been investigated for use in plastics including flax, hemp, jute, sisal and banana. Natural fibres have the advantage that they are renewable resources and have marketing appeal. These agricultural wastes used to prepare fibre reinforced polymer composites for commercial use.

During the application of composite materials to structures has presented the need for the engineering analysis the present work focuses on the fabrication of polymer matrix composites by using natural fibres and synthetic fibers and calculating its material characteristics (flexural modulus, flexural rigidity, hardness number, percentage gain of water) by conducting tests like flexural test, hardness test, water absorption test, impact test, density test and their results are measured on sections of the material and make use of the natural fibre reinforced polymer.

MATERIALS & MAKING

Epoxy LY556 of density 1.15–1.20 g/cm3, mixed with hardener HY951 of density 0.97–0.99 g/cm3 is used to prepare the composite plate. The weight ratio of mixing epoxy and hardener is 10:1. This has a viscosity of 10-20 poise at 250C. Hardeners include anhydrides (acids), amines, polyamides, dicyandiamide etc.

The laminate preparation is started as soon as the resin and hardener are mixed as the curing process gets started.A thin plastic mylar sheet of 300mm * 300mm is placed on a clean and flat wooden surface.Now the resin-hardener mixture is applied on the plastic film and spread properly on all sides using hand roller.The base fibre is placed on the resin, after which resin is poured on the fibre layer and using hand brush it is spread all over the fibre layer equally.The glass fibre is kept in the intermediate layer of the laminate. The natural fibres are chopped to minimal desired length to be kept in the top and bottol layers between the glass fibres.

The natural fibres are pineapple fibre 10 grams and sisal fibre 25 grams weighing is spread in the laminate. In the glass fibre and natural fibre which constitutes totally 9 plies (4 plies of glass fibres and 5 plies of natural fibre). The designation of hand lay-up is derived from the method of manually placing the fiber reinforcement on the mold surface. The liquid resin can be applied either manually from a container, or by a spray gun that dispenses the resin and curing agent mixture. Then "roll-out" the laminate to form the materials into the mold contours, tightly consolidate the laminate, and produce the appropriate proportions of resin and fiber reinforcement. Hand lay-up is a simple method for composite production. A mold must be used for hand lay-up parts unless the composite is to be joined directly to another structure. The mold can be as simple as a flat sheet or have infinite curves and edges. For some shapes, molds must be joined in sections so they can be taken apart for part removal after curing. Before lay-up, the mold is prepared with a release agent to insure that the part will not adhere to the mold.

The same process is repeated for all the fibre layers and after applying final layer of resin the laminate is covered with a plastic film wetted out with the mixture. The sheets of fibres are placed over the mold and rolled down into the mold using steel rollers. The material must be securely attached to the mold, air must not be trapped in between the fibres and the mold. Additional resin is applied and possibly additional sheets of fibres. Rollers are used to make sure the resin is between all the layers, the fibre is wetted throughout the entire thickness of the laminate, and any air pockets are removed. The work must be done quickly enough to complete the job before the resin starts to cure. Various curing times can be achieved by altering the amount of catalyst employed.

Mixing ratio:(sample-1)

Glass fibre – 30 * 30cm, 4 pieces
Sisal fibre – 20 grams
Epoxy resin – 700 grams
Hardener – 70 grams

Mixing ratio: (sample-2)

Glass fibre – 30 * 30cm, 4 pieces
Sisal fibre – 25 grams
Epoxy resin – 700 grams
Hardener – 70 grams

Other fabrication processes such as vacuum bagging, vacuum resin transfer molding and compression molding can be used with hand lay-up to improve the quality of the finished part or save time. If a finished cosmetic surface is required the first step in the process is to apply gel coat to the mold surface. The part is then fabricated from the outside to the inside, beginning with the gel coat finish and then progressing through various layers of the structural laminate. Depending on the requirements many layers of laminate can be built-up to produce a specified thickness that meets the structural requirements of the application. Hand layup, while one of the most basic composites/fiberglass molding processes(FRP), is widely used to produce a variety of transportation, marine and commercial products.

Tensile test specimen

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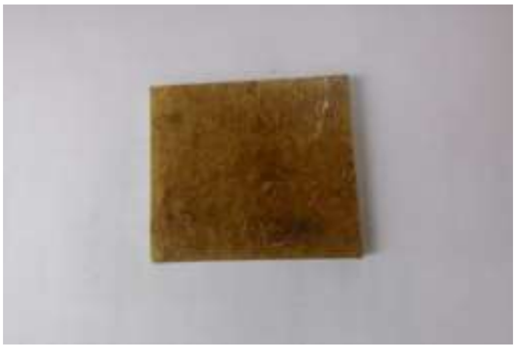
Sample tested in a flexural machine

Impact test specimen



Hardness Test specimen

EXPERIMENTAL RESULTS

Tensile test results table for hybrid composite fibre

Comparing the breaking load carrying capacity of the samples 1 & 2. The sample 2 is better load carrying capacity is 11.65 KN

Width (mm)	Thickness (mm)	Break load (KN)	Tensile strength N/mm^2	Tensile modulus kN/mm^2
13.7	5.05	6.245	91.167	14.326
13.7	5.05	11.650	170.07	26.225

Impact test results table for hybrid composite fibre

Width (mm)	Thickness (mm)	Energy (joules)
12.7	5.05	9.4
12.7	5.05	9.6

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comparing the maximum amount of energy the samples 1&2. The sample 2 is sustain maximum amount of energy is 9.6 joules.

Flexural test results table for hybrid composite fibre

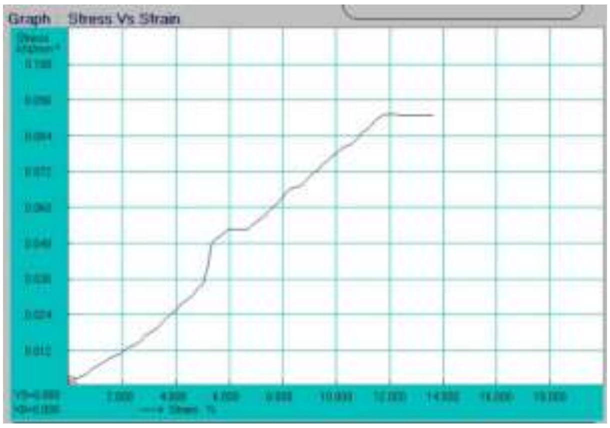
Width (mm)	Thickness (mm)	Break load (KN)	Flexural strength (N/mm^2)
12.9	5.05	0.860	398.29
12.9	5.05	0.725	335.77

comparing the maximum breaking load of load carrying capacity of sample 1&2. The sample 1 is the maximum flexural strength of 398.29N/mm^2

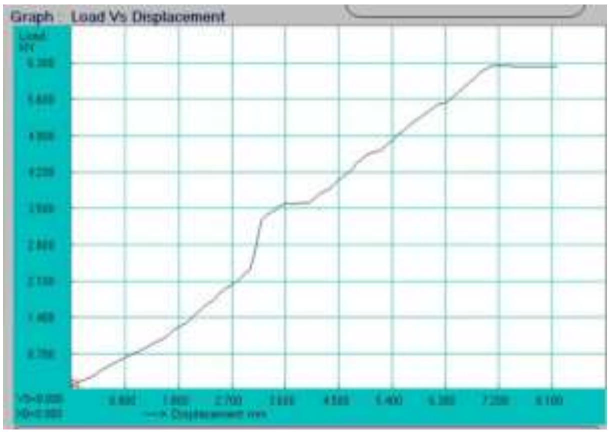
Rockwell hardness test results table for hybrid composite fibre

comparing the maximum hardness of the samples 1&2. The sample 2 is maximum hardness of their Rockwell Hardness Number is about 88.87

Sample 1



stress vs. strain for hybrid composite



Load vs. displacement for hybrid composite

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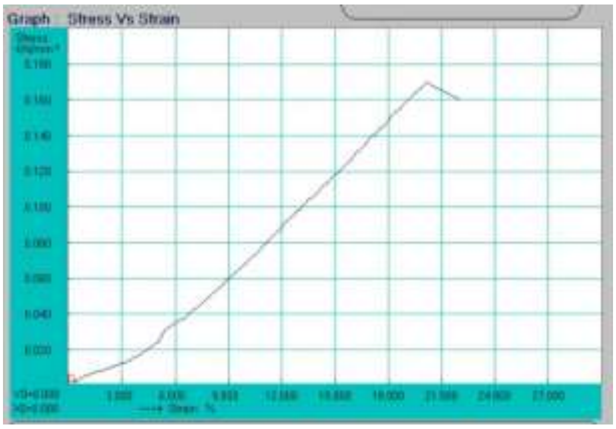
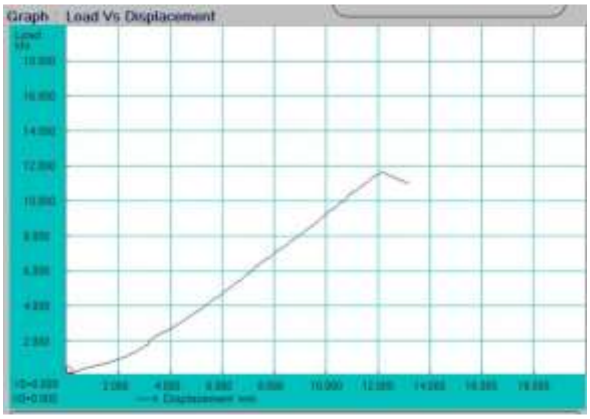
Sample 2



stress vs. strain for hybrid composite



load vs. displacement for hybrid composite

Sample 1
Flexural test

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Sample 2

Flexural test

CONCLUSION

The various properties of synthetic and natural fibre reinforced polymer composite are obtained and the specimens are made using hand layup method. The mechanical characteristics tests like tensile test, flexural test, water absorption test and impact test are conducted on the FRP, which is made of synthetic fibers are good in strength, high hardness and less water absorption capacity compare with natural fibers. These synthetic reinforced polymer fibers can use aerospace, automobile, boats, because they are better than the commonly used metals on basics of mass in the mean time the FRP.

The natural fibers are ecofriendly and the cost of production is lesser compared to the synthetic fibers. As for the use of natural fibres for reinforcement of polymers the density was expected to be lower than that of synthetic fibre reinforced polymer and mechanical properties was expected to be lower than of synthetic fibre reinforced polymer. Also the cost and health hazards will be minimized.

Based on the analysis made on the test results we have concluded that

1. As sisal and pineapple fibre are easily available and also cost effective these types of composites are effectively used.
2. The composite material made of sisal (25%) has good load carrying capacity than other fabricated composite materials.
3. The composite material made of sisal (20%) and pineapple (15%) also has better load carrying capacity.
4. The composite material made of sisal (25%) has good elongation properties and hence also not easily breakable.
5. The materials which we have fabricated shows good load carrying capabilities, therefore the material can be used for various applications such as switchboards, ceramic plates, trunk boot, body armor plate, brake lining, oil seal, chairs, bike visor, mudguard, bullet proof purposes.

From this it is very much clear that the materials, which we have fabricated, find application only in places where the load acting is maximum

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