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Investigation And Analysis Of Hybrid Composites Natural Fibre From Papaya Stem And Sisal Plant

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ABSTRACT :*Natural fibres are increasingly in demand across a wide range of polymer-composite material. They originate from plants, crops, animals, agro-wastes and other natural sources that are natural renewable and biodegradable after their end use. Global conservation concerns such as climate change and sustainability are encouraging development of totally green materials that can deliver eco-social system change. The aim of this project is to evaluate mechanical properties such as tensile and flexible properties and to make a composite material by the combination of papaya and sisal fibre. It has the uniqueness that they are renewable resources and have a good marketing appeal. These agricultural wastes can be used to prepare the fibre. These hybrid natural composite fibres have many advantages over plastics and other synthetic polymers. The hybrid composites were equipped by traditional cold pressing process at room temperature with a functional pressure of 20000kg/cm2 for 3 hours pressurization time. The fusion mixes with 68.5% of resin and 31.5% of fibre are used. In this project we are actually studying a three hybrid composites such as sisal/glass fibre, papaya/glass fibre, papaya/sisal/glass fibre. Here we are using glass fibre, a synthetic fibre for best finishing and to get a smooth surface. For the hybrid composite the general polymer resin (GP resin) is used as a binder. General polymer resin in the hybrid composite will result in the strong bond for the materials. The major mechanical properties such as Tensile, Hardness, and Flexural tests were conducted and are studied.*

KEYWORDS *-HybridComposites, Natural Fibre, Papaya Stem, Sisal*

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I INTRODUCTION

Natural fibres that are produced by plants and animals. It can be used as a component of composite materials. Natural fibres can also be converted into sheets to make products such as paper, felt, and fabric or can be moulded to make different materials. Natural fibres reinforced composites are the ones which can be termed as partially bio-degradable composites. Sisal fibre, papaya stem fibres are characterized by a low density, high moisture content, high tensile strength and they are very extensible comparing to other natural fibres. Composite materials are increasingly important for the production of light and stiff constructions for various applications. However, apart from the favourable mechanical properties, composites have some shortcomings. Primarily, the recycling of components turns out to be difficult and a large amount of composites end up in dumps or incinerators. Even though the energy value of the material is used, there is still a contribution to CO2 emanations and conservation pollution. Apart from that, the non-renewable resource mineral oil has to be used for some matrices and fibres, such as polymer matrices or carbon fibres. Therefore, alternatives are being highly looked after in view of dwindling resources and the increasing ecological awareness.

1.*INTRODUCTION TO HYBRID COMPOSITE MATERIAL*

Hybrid composites are composites that consist of two or more components in order to get a better material. The main phase is called reinforcing phase. The reinforcing phase materials may be in the form of fibre or flakes. The Matrix phase materials are continuous. The PMCs and MMCs are most commonly used. The polymer matrix composites consisting of polymer reinforced by fibres. The metal matrix composites have a metal matrix. Metals are mainly reinforced to increase or decrease the properties. The glass is the most commonly fibre used in polymer matrix composites because of its high strength, low cost, high chemical resistance and easy available fibre.

II LITERATURE REVIEW

Hybrid composites are materials which are made by combining two or more different types of fibres in a common matrix. Hybrid of fibres consuming same length and dissimilar diameter offer some lead over the use of one kind of fibres alone in a polymer matrix. This fibres possess have a good calorific value and they show excellent mechanical properties and have low density and are inexpensive. Natural fibre composites are durable have good maintenance, renewable and cost effective as liken to synthetic fibre composites. Made the experiment on mechanical properties of jute fibre reinforced composites with polyester and epoxy resin. In this study they revealed that the jute-epoxy exhibited better mechanical properties. The processing time essential for jute-polyester composite is moderately lesser time than jute-epoxy [1]. In this Study the hybrid consequence of composites through of jute/E-Glass fibres are finished by hand layup method. It is found that the hybrid composite has improved strength as associated to jute fibre composite variety discretely with glass fibre [2, 3]. The integration of glass fibre in jute fibre composites increases the mechanical properties and it indications to the increase of the application of natural fibres in various mechanical stuffs of sisal, jute and glass fibre reinforced polyester composites they observed that the accumulation of glass fibre into jute fibre composites resulted in maximum tensile and flexural strength.[4] Studied the mechanical properties of jute/glass reinforced polyester with water absorption condition. Composites are subjected to various water conditions and test were performed by immersing composite specimen in to three different water conditions, distilled water, sea water and acidic water and water was in room temperature for a period of three weeks and also effect of the various water environments on the flexural and compression characteristics were investigated in this study. It found out that the jute composite is not fit for underwater applications. Negotiate that the composite with 50% sisal glass fibre and 50% resin combination has maximum tensile strength. It is found that breaking load of sisal-glass fibre reinforced composite is 1.5 times higher than sisal-coir-glass fibre reinforced composite and 1.33 times higher than coir-glass fibre reinforced composite [5]. The percentage elongation of coir glass fibre reinforced composite is found as higher than the other composites and hence it may have more ductile property in nature. The hybrid with compound with 40% sisal- coir-glass stuffs and 60% resin blend has great flexural strength and high impact strength. The compressive strength and impact strength of unsaturated polyester based sisal and glass hybrid composite have been deliberate as a function of fibre content [6]. It is observed that the compressive and impact strength of sisal/glass fibre hybrid component is higher than sisal fibre reinforced composite, but lower than the glass reinforced composite. When the load is applied on sisal and glass fibre hybrid composite, first sisal fibre fails, then the load is shifted to glass fibre. So that the presence of glass fibre in the sisal and glass fibre hybrid composite causes to improve the impact and compressive strength. At the same time the presence of sisal fibre in hybrid composite the causes to decrease the compressive and impact strength than the glass fibre composite.[7] the effect of glass fibre in hybrid composites. By the addition of glass fibre improves the thermal stability of the composites. Hybridization with glass fibres decreased water absorption of the sisal polypropylene composites. Tensile, flexural, impact properties of the sisal-polypropylene composites were increased by adding the glass fibre.[8]The author tried to increase the mechanical properties of sisal fibre reinforced epoxy composites by varying the fibre length and keeping constant weight percentage of sisal fibre content. Tensile strength of epoxy was not improved by the reinforcing of sisal fibre while tensile modulus, flexural and impact properties were improved. Impact properties of sisal composites were found maximum for the composites having more fibre length.[9]The jute and glass fibre hybrid composite leads to the successful fabrication of glass, jute fibre and chopped fibre reinforced polyester composites with different fibre lengths is possible by simple hand lay-up technique. The mechanical properties of the composites like tensile, flexural and impact strength of the composites are also greatly influenced by the fibre length[10]The author has been carried out a review to make use of natural fibres(such as sisal, jute, banana, bamboo etc). The mechanical and physical properties of natural fibres have varies from fibre to fibre the consequence of epoxy resin in the composite factual. The epoxy resin may have noble mechanical properties but they have lack of thermal properties. Under great temperature they willpower catch fire easily [11].The addition of filler comprising of a amalgamation of silicon and carbon black powders decrease the minor amount residual free silicon but enlarged the amount of inner reaction bonded SIC and plaster reduced the flexural strength indicating mutilation to the fibre but it extremely improved the wear resistance characteristics of the composites [12]. As the percentage of Si-C content increases, the area under the curve spreads across the wider range and the peak value shifts towards the higher temperature region resulting in the increase in elastic range of the composites. The fibre properties such as hardness, tensile strength, flexural strength and impact strength increases with the increase in Si-C filler content [13]. Experimental results show that Si-C filled composites having high impact strength. When equate with other filled composites this due to that good bonding strength between filler, matrix and fibre and flexibility of the interface molecular chain resulting in absorbs and disperses the more energy, and prevents the crack initiator effectively [14]. The flexural strength results shows that composites filled by Si-C exhibited maximum flexural strength when compared with other filled composites but lower than the unfilled composites equate between particulate filled and unfilled glass polyester composites were presented on the basis of mechanical and thermo-mechanical properties. It was noticed that, with an increase in the filler content, the mechanical properties decreased. In the case of the unfilled composites, an increase in the fibre loading increased the mechanical properties simultaneously. However, in the case of dynamical mechanical analysis and thermal analysis [15].

III EXPERIMENTAL DETAILS

A. PROBLEM IDENTIFICATION

The synthetic polymer materials are currently used in many industrial areas to meet light weight and high strength requirements and these materials are not eco-friendly to the environment. However, with the increasing amount of synthetic polymer materials present environmental issues such as disposal and treatment of wastes, waste disposal services are becoming increasingly important.

B. PROBLEM DEFINITION

We have studied all the problems such as environmental issues, waste disposal and treatment problems by the usage of synthetic polymers. So for solving this problem we have decided to replace the synthetic polymers by the usage of natural fibres. So by usage of natural fibres all these environmental problems can be solved

C. MATERIAL USED

General Polymer resin,Accelerator-cobalt,Mouldingbox, Combination of fibres – Sisal and papaya stem, Glassfibre, Mould release spray (silica),Hardener

Chopped sisal and papaya fibres (harvested in 2018) were used as reinforcement materials. These fibres were procured from plants grown in Kerala and Tamilnadu, India. General polymer resin and corresponding hardener were used to fabricate hybrid composite natural fibre. This is a low temperature curing system. The matrix material was prepared with mixture of general polymer resin and hardener in the ratio of 10:1.Figures 1-6 shows the sample picture of our research work.

D. EXTRACTION OF NATURAL FIBRE FROM SISAL

Step 1: Taking sisal leaf from sisal plant
Step 2: Crushing the sisal leafs to obtain fibre
Step 3: Fibre obtained after crushing

Fig.1.Sisal plant leaf

Fig.2. Crushing the sisal leaf

Fig.3. Sisal leaf fibre

E. EXTRACTION OF NATURAL FIBRE FROM PAPAYA STEM

Step 1: Taking papaya tree
Step 2: Cutting the papaya stem to obtain fibres
Step 3: Fibre obtained after crushing

Fig.4. Papaya plant

Fig.5. Papaya stem

Fig.6. Papaya stems fibre

F. HYBRID COMPOSITE PREPARATION

Compression moulding process was used to make hybrid compound natural fibres. The hydraulic persistent machine was used to make the samples. Both upper and lower dies were treated with a thin layer of polyethylene sheet to ensure the superior exterior finish. Overall polymer resin and hardener were varied in a bowl to prepare the matrix material. Sisal, papaya and glass fibre were mixed and added in to matrix. The amount of reinforcement is kept constant at 68.5% of resin and 31.5% of fibre. A well-mixed mixture of matrix and fibres was poured into the female die cavity. The upper die was placed on the lower die and pressurized to 20000kg/cm2from hydraulic pressing machine for 3 hours. After setting the fibre plates are obtained.

IV PROBLEM FORMULATION

Papaya fibre and Sisal fibre were collected from local nearby area. The general polymer resin, Hardener and accelerator (cobalt) were purchased along with the mould release spray (silica)

Fig.7.G-Presin

Fig.8.Cobalt

Fig.9.The dies

Fig.10.Glass fibre

On a sheet metal plate we place a polyethylene layer sheet. On the sheet we spread silica all over it as silica. Here we are minimizing the usage of synthetic fibre by the inclusion of natural fibre as the major portion. Here for the purpose of testing we are making three samples for the comparison of strength, hardness and other properties. Figure 7, 8 shows the polymer resin and cobalt; Figure 9 and 10 shows die set and glass fibre.

G. FOR SAMPLE 1

The composite made by following manner

(Glass fibre + sisal fibre)+ (GP resin+ hardener + accelerator)

(31.5%) + (68.5%)

H. FOR SAMPLE 2

(Glass fibre + papaya fibre)+ (GP resin + hardener +accelerator)

(31.5%) + (68.5%)

I. FOR SAMPLE 3

(Glass fibre + papaya fibre + sisal fibre) + (GP resin + hardener + accelerator)

(31.5%) + (68.5%)

For all the three samples the procedures are all same. Here only the fibre varies that is different natural fibres such as papaya and sisal is used. And after taking proper fibre and the necessities for making the sample we are ready to prepare the first sample.

The mould plate after the application of silica is filled with the solution of hardener and general polymer resin. Along with the solution the curing agent of 2mL is added. Here we have taken 68.5% as resin and 31.5% as fibre. This ratio is taken as constant.

Then above the plate the glass fibre is placed and a roller is rolled over it for easy setting .Then over the glass fibre again the mixture of resin, hardener and the curing agent is added and the layer of papaya fibre is placed without gaps. Again the solution is spread over the papaya and glass fibre is placed and again roller is rolled over it for easy setting. After that sisal fibre is placed over the glass fibre and the solution is mixed with it.

Finally glass fibre is placed at the topmost layer and is covered by polyethylene sheet at all sides. Then a metal plate is placed over the sheet in order to compress it with the help of compression moulding machine.

Fig.11.Comperession moulding press

Then it is kept for 3 hours for setting finely after the setting period is over we have obtained the specimen and the same procedure is followed for the next two specimens

The first paragraph under each heading or subheading should be flush left, and subsequent paragraphs should have a five-space indentation. A colon is inserted before an equation is presented, but there is no punctuation following the equation. All equations are numbered and referred to in the text solely by a number enclosed in a round bracket (i.e., (3) reads as "equation 3"). Ensure that any miscellaneous numbering system you use in your paper cannot be confused with a reference [4] or an equation (3) designation.(10)

V. RESULT AND DISCUSSION

J. FLEXURAL TESTING

Flexural strength is the capacity of the material to resist bending forces applied perpendicular to its longitudinal axis. Sometime it is referred as cross breaking strength. Where extreme stress advanced when a bar-shaped test part acting as a simple beam is exposed to a bending force perpendicular to the bar. There are two approaches that cover the purpose of flexural properties of quantifiable: three point loading system and four point loading system. As described in ASTM D790, three point loading system applied on a supported beam was utilized. Flexural test is important for designer, if the service failure is significant in bending. Here we have conducted flexural test for 3 samples. Sample 1 consists of sisal and glass fibre, sample 2 consists of papaya, glass fibre, sample 3 consists of papaya, glass fibre and Sisal. While we have conducted flexural test for all three samples we get maximum flexural strength of 165.620 MPa for a peak load of 1.2KN.


Fig.13.Sisal, glass fibre and resin composite


Fig.13. Papaya, glass fibre and resin composite


Fig.14.Sisal, Papaya, glass fibre and resin composite

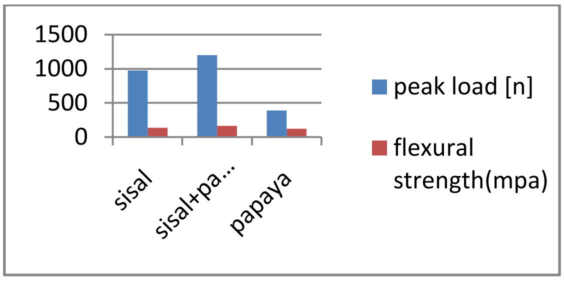

Fig.15.Flexural strength graph

K. IZOD IMPACT TESTING

Izod impact test were carried out according to ASTM D256, ISO 180 standard respectively. It is a single point test that measures a materials resistance to impact from a swinging pendulum. It is defined as the dynamic energy needed to recruit breakage and remain the fracture until the sample is damaged. While we had showed the Izod impact test our combination was observed better result (3.90J).Figure 16 shows the Izod impact graph which is compound of sisal and papaya have further strength. And also table 1 show the test reports.

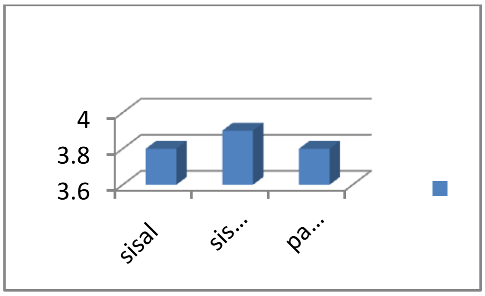

Fig.16.Izod impact test of hybrid composite

Table 1.Test report for samples

Sample No	CS Area [mm²]	Peak Load [N]	Flexural Modulus (GPa)	Flexural Strength(MPa)
1	114.000	974.427	134.625	6779.448
2	114.000	1198.772	165.620	128.390
3	76.000	391.291	121.635	7821.988

VI. CONCLUSION

The characteristics of hybrid composite natural fibres analysed here from sisal, papaya trees and glass fibre. Knowledge of the structure and compositions of these three fibres will provide data for comparison in future studies. Experimental investigation of flexural and izod impact test properties of hybrid composite natural fibre lead to the following conclusions.

1. Successful fabrication of hybrid composites natural fibre can be achieved by traditional compression moulding method.
2. The combination of sisal and papaya with glass fibre hybrid composite exhibits more impact and flexural strength than other hybrid composites.
3. The mixing of natural fibre with Glass-Fibre reinforced polymers are finding increased applications.
4. Combination of natural fibres with synthetic fibres decreases the maximum absorption and increases the mechanical properties of the composites.

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