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EXPERIMENTAL INVESTIGATION OF MECHANICAL PROPERTIES IN HYBRID NATURAL FIBER

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ABSTRACT

The invention is an effort to utilize the advantages offered by renewable resources for the development of composite materials based on polymer and particles of natural fibers for Conservation of natural resources. In this research, natural fibers like Bamboo and Rubber (hybrid) are fabricated with polyester resin using molding method. The applications of these materials require a sustainable approach to creating green products. Green materials are very important to form environment friendly from renewable resources. Nowadays natural fibers form an interesting alternative for the most widely applied fiber in the composite technology The work presents a brief over view of the improvement of the Mechanical properties (tensile, flexural and impact test) of natural fibers. Knowing that natural fibers are cheap and have a better stiffness and lighter components. In this work tensile and impact and flexural test of Bamboo and Rubber (hybrid) composite.[1]

Keywords **Hybrid fibre composites, polyester, Mechanical properties.**

1. INTRODUCTION

Natural fibers are an attractive research area because they are eco-friendly, inexpensive, Abundant and renewable, lightweight, low density, high toughness, high specific properties, biodegradability and non-abrasive to processing characteristics, Therefore, natural fibers can serve as reinforcements by improving the strength and stiffness and also by reducing the weight of the resulting bio composite materials although the properties of natural fibers vary with their source and treatments.[3]Nowadays, the natural fibers such as Bamboo and Rubber have the potential to be used as a replacement for Vehicle Parts or other traditional reinforcement materials in composites. Other advantages include low density, low cost, high tensile strength, high toughness, comparable specific strength properties, reduction in tool wear, ease of separation, decreased energy of fabrication. Composites are materials that comprise strong load carrying material (known as reinforcement) imbedded in weaker material (known as matrix). Reinforcement provides strength and rigidity, helping to support structural load. The matrix, or binder (organic or in-organic) maintains the position and orientation of the reinforcement. They have high specific properties such as stiffness, impact resistance. In addition, they are available in large amounts and are renewable and biodegradable. Other desirable properties include low cost, low density. Here we take 5 ratio of mixing the bamboo and rubber fiber. It is well understood now that both the strength and stiffness of fiber composites depend on fiber concentration, fiber aspect ratios, fiber matrix adhesion, as well as powdered particles of Rubber and stick particles of bamboo fiber orientation and dispersion. The present contribution reports utilization of untreated Bamboo and Rubber fibers as reinforcing fillers for polyester resin. The Bamboo (hybrid) and Rubber (hybrid) fiber-reinforced polymer composites were prepared using hand molding method. The effects of fibers content on mechanical properties such as, tensile, flexural and impact of the composites were investigated and reported.[1]

Natural Fiber Reinforced PolymerComposites For Automobile Accessories (Chandramohan, D. and J. Bharanichandar **)**

All these studies show the excellent capability of biocomposites to be processed to structural parts. The weight-related properties also allow to aim at applications which are today dominated by glass fibre reinforced plastics. Nevertheless, there a restrictions with respect to extreme environmental conditions. An essential branch of applications is to be seen e.g. in covering elements with structural tasks in automobileand railway design, in furniture industry and in the field of leisure industry.

A Review on Investigation on the Influence of Reinforcement on Mechanical Properties of Hybrid Composites (H.B. Vinay1,*, H.K. Govindaraju2 and Prashanth Banakar3)

From the above literature survey most of the engineering applications were made by hybrid compositematerial so that it can reduce the cost of the fibers and having high strength & stiffness for differentusages. It is imperative that the use of polymer laminated composites is an emerging field in allsectors of the industries because of its benefits of high strength to weight ratio in order to enhanceperformance.

2. EXPERIMENTAL AND PROCEDURE

In this investigation the bamboo and rubber fibers were taken to reinforce with the polyester resin.

2.1 Bamboo

Bamboo plants are giant, fast-growing grasses that have woody stems. The characteristics of each vary in size, growth habit, sun tolerance, soil moisture needs and heat/ cold temperature tolerance. Several investigators have examined bamboo as a source of best fiber and as a source of cellulose from pulping the bamboo One of benefits using bamboo fibers is that the bamboo is an abundant natural resource in Asia and Middle & South America. Bamboo fibers are often known as natural glass fiber due to its high strength with respect to its weight derives from fibers longitudinally aligned in its body. The tensile strength of bamboo is relatively high and can reach 370 MPa. This makes bamboo an attractive alternative to steel in tensile loading application.[5]

2.2 Rubber

All rubber like materials are polymers, which are high molecular weight compounds consisting of long chains of one or more types of molecules, such as monomers. Vulcanization (or curing) produces chemical links between the loosely coiled polymeric chains; elasticity occurs because the chains can be stretched and the cross links cause them to spring back when the stress is released. Natural rubber is a polyterpene, i.e., it consists of isoprene molecules linked into loosely twisted chains. The monomer units along the backbone of the carbon chains are in a *cis* arrangement (see isomer) and it is this spatial configuration that gives rubber its highly elastic character. In gutta-percha, which is another natural polyterpene, the isoprene molecules are bonded in a *trans* configuration leading to a crystalline solid at room temperature. Un vulcanized rubber is soluble in a number of hydrocarbons, including benzene, toluene, gasoline, and lubricating oils.Rubber is water repellent and resistant to alkalies and weak acids. Rubber's elasticity, toughness, impermeability, adhesiveness, and electrical resistance make it useful as an adhesive, a coating composition, a fiber, a molding compound, and an electrical insulator. In general, synthetic rubber has the following advantages over natural rubber: better aging and weathering, more resistance to oil, solvents, oxygen, ozone, and certain chemicals, and resilience over a wider temperature range. The advantages of natural rubber are less buildup of heat from flexing and greater resistance to tearing when hot.

2.3 Polyester Resins

Polyester resins are relatively inexpensive, fast processing resins used generally for low cost applications. Low smoke producing polyester resins are used for interior parts of the aircraft. Fiber rein forced polyesters can be processed by many methods. Common processing methods include matched metal molding, wet layup, press (vacuum bag) molding, injection molding, filament winding, and autoclaving.[4] Polyesters offer ease of handling, low cost, dimensional stability, as well as good mechanical, chemical-resistance and electrical properties. Polyester resins are the least expensive of the resin options, providing the most economical way to incorporate resin, filler and reinforcement. They are the primary resin matrix used in SMC (sheet molding compounds) and BMC (bulk molding compounds). Polyester resins are thermo set polyesters that are created by combining a glycol (like ethylene glycol) with an alcohol (like phthalic or maleic acid). Water is given off in what is known as a condensation reaction. The low viscosity and raw material cost of polyesters make the additions of filler and reinforcements a matter of practicality. In fact, filler is often called an extender, because it extends the value of the resin - reducing the cost of the final composite on as much as 50%. It is possible to add or reduce strength with the reinforcement chosen.

2.4 Chemical treatment

After the fibers were collected, the coir was allowed to under growth the chemical treatment by using the 6-8% of NaOH with the distilled water. This treatment was used to remove the lignin content in the fiber. The lignin content may affect the Young's modulus of the fiber. So, the fiber was treated by using the NaOH.[2]

2.5 Mould preparation

To prepare the composite, polyester resin was used as matrix material. The bamboo and rubber fiber hybrid composite sheets were manufactured by simple hand lay-up process in a mould. The mould was prepared to fabricate the test specimen. The dimensions of the mould were 300mmx300mmx24mm. Nine hybrid composites with different combinations of rubber fiber content (7, 4, 5, 6, and 3wt%) and bamboo fiber content (3, 6, 5, 4, and 7wt%) were designed and produced. After the curing process, test samples were cut according to the sizes of ASTM standards[2].

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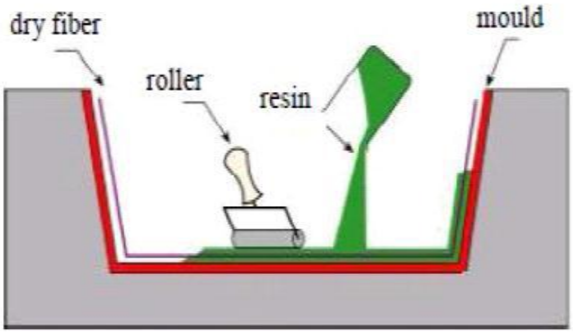

Fig -1 Hand lay up method

2.6 Methodology

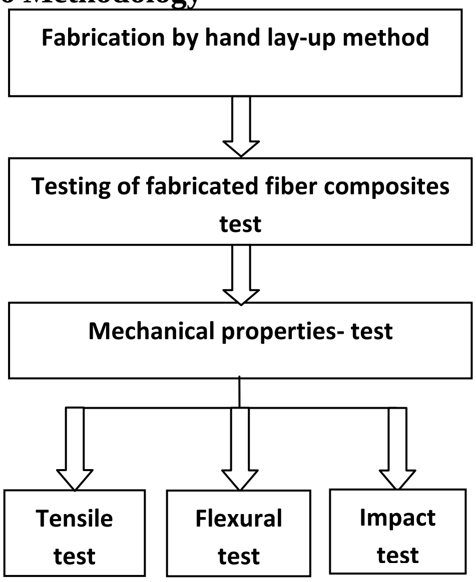

Fig – 2 Methodology[3]

2.7 Mechanical Tests

The samples of pre-fixed fiber content of produced hybrid dfiber reinforced composites were investigated for their tensile,flexural and impact properties. Both tensile, flexural and impactstrength tests were conducted for all the five samples.[2]

2.7.1 Tensile Strength Test

Tensile testing, also known as tension testing, is a fundamental materials science test in which a sample is subjected to a controlled tension until failure. The results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under other types of forces. Properties that are directly measured via a tensile test are ultimate tensile strength, maximum elongation and reduction in area. From these measurements the following properties can also be determined: Young's modulus, Poisson's ratio, yield strength, and strain-hardening characteristics. Uniaxial tensile testing is the most commonly used for obtaining the mechanical characteristics of isotropic materials. For anisotropic materials, such as composite materials and textiles, biaxial tensile testing is required.the tensile strength of the composites was measured with auniversal testing machine in accordance with the ASTM ASTM D638 procedure. The speed of the tensile testing machine is about2mm/min. The tensile strength of all five combinations isshown in Fig -3[2]

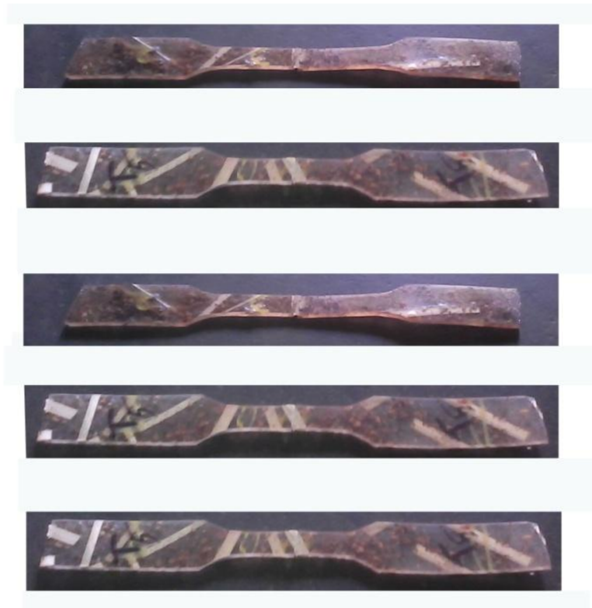

Fig – 3 Before tensile test material

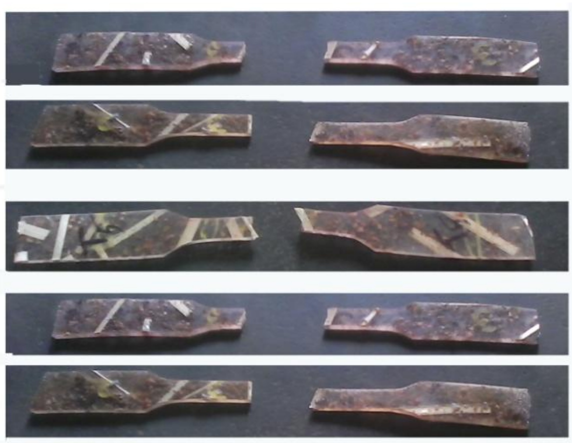

Fig –4 After tensile test material

2.7.2 Flexural Strength Test

The flexural test measures the force required to bend a beam under three point loading conditions. The data is often used to select materials for parts that will support loads without flexing. Flexural modulus is used as an indication of a material’s stiffness when flexed. Since the physical properties of many materials (especially thermoplastics) can vary depending on ambient temperature, it is sometimes appropriate to test materials at temperatures that simulate the intended end use environment.the flexural strength of the composites was also done byuniversal testing machine in accordance with the standard ofASTM D790. The speed of the machine is about 2mm/min. The flexural strength of all five combinations is shown in Fig – 5[2]

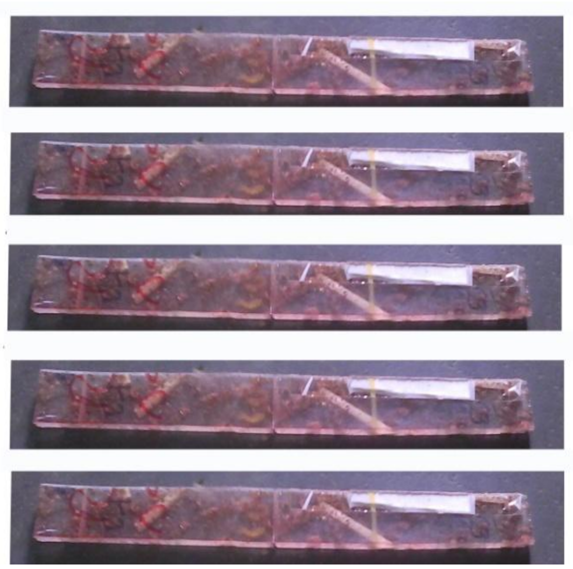

Fig – 5 Flexural test material

2.7.3 Impact Strength Test

The izod impact test was conducted to find the impact energyin accordance with the standard of ASTM D256.[2]the area beneath a stress/strain curve produced from a tensile test is a measure of the toughness of the

MIXING RATIO	TENSILE STRENGTH (Mpa)	FLEXURAL LOAD (KN)	IMPACT ENERGY (Joules)
RUBBER-BAMBOO 7:3	14.7	0.22	2
RUBBER-BAMBOO 4:6	16.89	0.11	2
RUBBER-BAMBOO 5:5	15.47	0.18	2
RUBBER-BAMBOO 6:4	16.42	0.07	2
RUBBER-BAMBOO 3:7	21.42	0.26	2

test piece under slow loading conditions. However, in the context of an impact test we are looking at notch toughness, a measure of the metal's resistance to brittle or fast fracture in the presence of a flaw or notch and fast loading conditions.

3. RESULT AND DISCUSSION

Table – 1 Test report

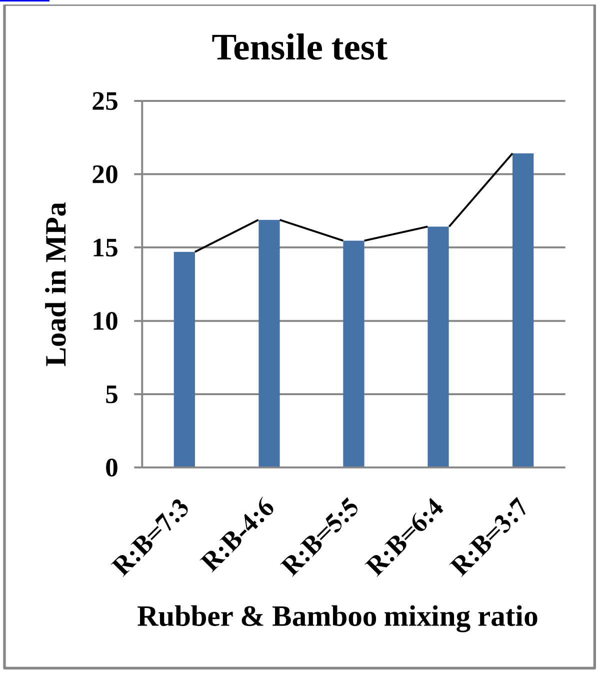

Fig – 6 Tensile test chart (Mpa)

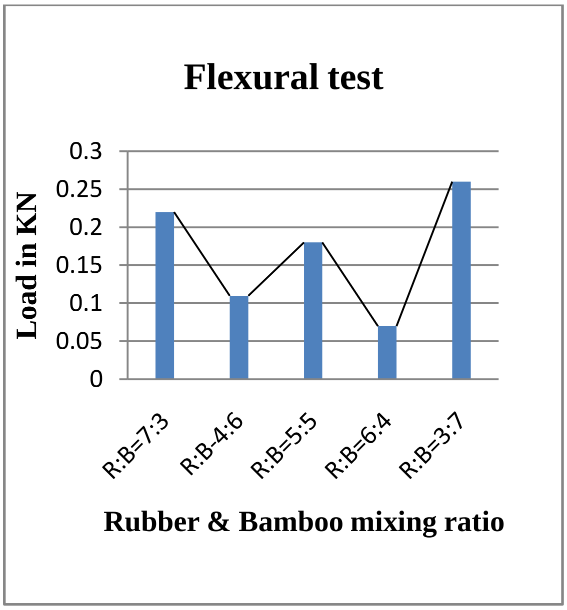

Fig – 7 Flexural test chart (KN)

4. GRAPH

4.1 Tensile test

Input Data

Mode of Test	:	Tension
Sample type	:	Flat
Thickness	:	4.50mm
Width	:	12.20mm
Area	:	$54.90mm^2$
Gauge Length	:	100mm

Final Gauge Length : 0.000mm

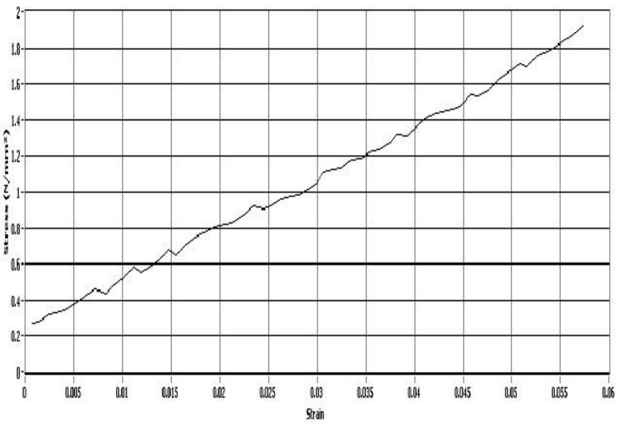

Fig – 8 Maximum tesile strength for Rubber:bamboo=3:7

Results

Fmax : 1.18KN

UTS : 21.42Mpa

4.2 Flexural test
Input Data

Mode of Test	:	Compression
Sample type	:	Flat
Thickness	:	5.20mm
Width	:	29.30mm
Area	:	152.36mm^2
Gauge Length	:	100mm
Final Gauge Length	:	0.000mm

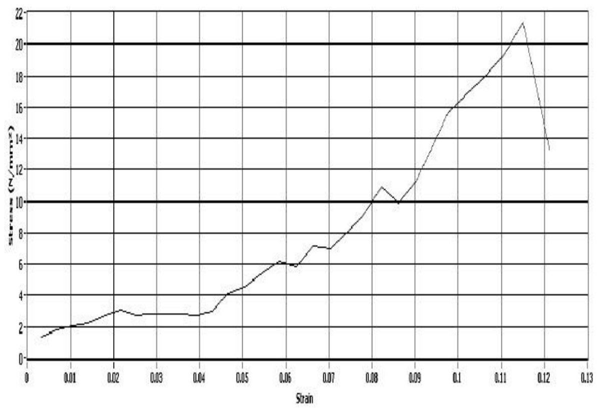

Fig – 9 Maximum Flexural load for Rubber:bamboo=3:7

Results

Fmax : 0.26KN

5. CONCLUSION

Thus the comparison of tensile, flexural and impact strength for different combination of bamboo and rubber fiber contents with polyester resin were done and the optimal mixing of fibers weight ratios were calculated for the effective tensile strength, flexural strength and the impact energy. In this present work, we found out that the 3% of rubber fiber and 7% of bamboo fiber with standard polyester resin resulted the best values of tensile strength, flexural strength and impact energy i.e., 21.42MPa, 0.26KN and 2 J. Here, the second-order polynomial curve fitting equations were modeled which predicts the values of tensile, flexural and impact strengths with various other combination of fibers contents with resin. Thus the bonding between fibers and polyester resin was extremely high.

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