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EFFECT AND ANALYSIS OF NATURAL FIBRE POLYMER COMPOSITE PLATES USED FOR PASSENGER VEHICLES BUMPER

Dr.Vemuri Lakshminarayana
Professor & Principal, Dept of Mechanical Engg
Sree Sastha college of Engg
Chennai-123
vlm_vamsi@yahoo.com

Vincent Balu.P
Department of Mechanical Engg
Sree Sastha college of Engg
Chennai-123
vincent.balu@gmail.com

ABSTRACT

Bumper is one of the main parts which are used as protection from front and rear collision[3]. Weight reduction is primary concern area of design, in today's automobiles. Fiber reinforced composite are material that may offers advantages in terms of weight and cost when compared with steel and aluminum structure.

The impact bumper beam in front side of automobile is main structure for absorption the kinetic energy at the time of impact. New composite material is introduced in this project that sisal fiber mat with epoxy resin and also sisal fiber mat with polyester resin to absorb most kinetic energy during impact timing. This project tries to replace the existing steel bumper with natural fiber (sisal fiber) composite bumper

beam. Fabrication of natural fiber (sisal fiber) composite bumper is carried by hand layup process. The tensile, izod and flexural tests are conducted over these two composite plates to absorb the properties.

Keywords: bumper, natural fibre,composite, sisal fibre,Reinforcement

I. INTRODUCTION

In recent years, polymeric based composites materials are being used in many application such as automotive, sporting goods, marine, electrical, industrial, construction, household appliances, etc. Polymeric composites have high strength and stiffness, light weight, and high corrosion resistance. Natural fibres are available in abundance in nature and can be used to reinforce polymers to obtain light and strong materials. The information on the usage of banana fibre in reinforcing polymers is limited in the literature. In dynamic mechanical analysis, have investigated banana fibre reinforced polyester composites and found that the optimum content of banana fibre is 40%. The analysis of tensile, flexural, and impact properties of these composites revealed that composites with good strength could be successfully developed using banana fibre as the reinforcing agent. The source of banana fibre is the waste banana trunk or stems which are abundant in many places in the world.

Nature continues to provide mankind generously with all kinds of rich resources in plentiful abundance, such as natural fibres from a vast number of plants. However, since the last decade, a great deal of emphasis has been focused on the development and application of natural fibre reinforced composite material in many industries. Needless to say, due to relatively high cost of synthetic fibres such as, glass, plastic, carbon and Kevlar used in fibre reinforced composite, and the health hazards of asbestos fibres, it becomes necessary to explore natural fibre, like banana fibres.

The natural fiber has advantages such as low density, appropriate stiffness, mechanical properties with high disposability and renewability. Banana fiber, a lingo-cellulosic fiber, obtained from the pseudo-stem of banana plant is the best fiber with relatively good mechanical properties. In tropical countries like India, fibrous plants are available in abundance and some of them like banana are agricultural crops. Banana fiber at present is a waste product of banana cultivation. Hence, without any additional cost input, banana fiber can be obtained for industrial purposes. Banana fiber is found to be good reinforcement in polypropylene resin. The properties of the composites are strongly influenced by the fiber length.

II. THE NEED FOR HYBRID COMPOSITES

A hybrid composite is one which has two or more than two different reinforcement fibers inside the matrix. The interest in natural fibers was generated due to the high material and processing cost, toxicity and specific gravity of the synthetic fibers. But, the use of natural fibers has been somewhat restricted as they have poorer mechanical properties as compared to the synthetic fibers. Some of these drawbacks are namely, high moisture absorption, poor wet ability, limited thermal stability and poor adhesion properties of natural fibers. Hybridization allows the composite designers to tweak the properties of the composite material as per their specialized requirements. As the whole idea behind composites is to get the best of all constituents, hybrid composites allow an excellent opportunity to get the best cost and performance ratio.
Randomly oriented hybrid fibers are gaining much popularity. The constituent fibers are intimately mixed such that no clusters of either type are present in the Composite have observed a considerable improvement in the in the mechanical properties of Low Density Polyethylene (LDPE) based short banana-glass fibers. Have studied and reported an increase in the Impact strength of PVC based banana-glass fiber hybrid composite., confirm that you have the correct template for your paper size.

III. MATERIALS AND PREPARING METHODS

The materials used and methodologies adopted during the fabrication, sample preparation, mechanical testing and characterization of the hybrid composites are explained below. The raw materials used in the study are:

i) Epoxy resin

ii) Sisal Fiber

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iii) Polyester resin
iv) Hardener of epoxy
v) Hardener of polyester
vi) Accelerator of polyester

*Epoxy resins are available in liquid and solid forms and are cured into the finished plastics by a catalyst. They are cured at room temperatures as well as elevated temperatures of about 2750C. The erosion resin of grade LY-556 was used of density 1.1-1.2gm/cc at 298K. It having the following outstanding properties has been used as the matrix material.

a) Excellent adhesion to different materials.
b) High resistance to chemical and atmospheric attack. High dimensional stability.
c) Free from internal stresses.
d) Excellent mechanical and electrical properties. Odorless, tasteless and completely nontoxic. Negligible shrinkage.

Sisal fiber and Alkali treatment

Banana fiber is a natural fiber with relatively good mechanic properties. The diminutive second-generation Mercedes-Benz A-Class designed the spare tire recess covered with a composite material, polypropylene thermoplastic with embedded banana fibers, abaca, with high tensile strength and rot-resistant. It can withstand stone strikes and exposure to the environment, such as ultraviolet from the sun, water, some chemicals. Using abaca fiber is saving energy because conventional glass fibers production requires 60% more energy than this natural fiber.

Softening of sisal fibres through Alkali treatment

Sodium Hydroxide (NaOH) treatment removes impurities from the fiber surface, Banana fiber sample were treated with three different conc. of NaOH to soften the fiber and make it suitable for spinning. The

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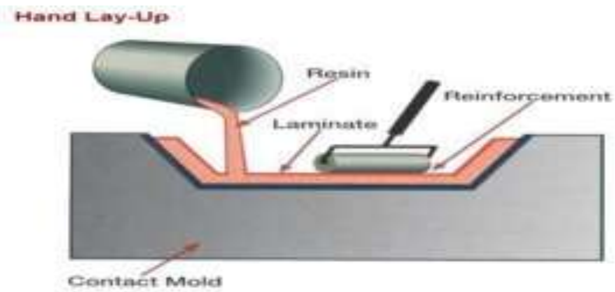
concentrations used were 0.5%, 1%, 1.5% weight/volume. Treatment was done with sample: liquor ratio of 1:30.Standard procedure used in the institute is as follows[2].



In the present study 200 grams of sisal fibres were used per concentration. Since the NaOH used was 1:30 total solution used in each case was 6 litres. For preparation of NaOH solution, 1% NaOH solution was used .

HARDENER MIXING

The hardener, often an amine, is used to cure the epoxy by an addition reaction. The chemistry of this reaction means that here are usually two epoxy sites binding top each amine site. Since amine molecules co-react with the epoxy molecules in the fixed ratio, it is essential that the correct mix ratio is obtained between resin and hardener to ensure that complete reaction takes place. The hardener used in the current manufacturing process is of grade HY951, which was added to epoxy resin to provide proper strengthening.

Fig.1. Process – Hand lay-up

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SAMPLE PREPARATION

Hand lay-up

Hand lay-up is a simple method for composite production. A mould must be used for hand lay-up parts unless the composite is to be joined directly to another structure. The mould can be as simple as a flat sheet or have infinite curves and edges. For some shapes, moulds must be joined in sections so they can be taken apart for part removal after curing. Before lay-up, the mould is prepared with a release agent to insure that the part will not adhere to the mould. Reinforcement fibers can be cut and laid in the mould. It is up to the designer to organize the type, amount and direction of the fibers being used. Resin must then be catalyzed and added to the fibers. A brush, roller or squeegee can be used to impregnate the fibers with the resin. The lay-up technician is responsible for controlling the amount of resin and the quality of saturation. Figure 1 shows the basic process of hand lay-up. Other fabrication processes such as vacuum bagging, vacuum resin transfer moulding and compression moulding can be used with hand lay-up to improve the quality of the finished part or save time[1]

The banana fiber and glass which is taken as reinforcement in this study is collected from local sources. The epoxy resin and the hardener are supplied. Wooden moulds having were first manufactured for composite fabrication. The banana fiber and S-Glass fibers are mixed with epoxy resin by simple mechanical stirring and the

Mixture was poured into various moulds, keeping in view the requirements of various testing conditions and characterization standards. The composite samples of nine different compositions (S-1 to S-8) are prepared. The composite samples S-1 to S-8 are prepared in three different percentages of Glass and banana fibers (20 wt % and 30 wt %). This is done while keeping the epoxy content at a fixed percentage (i.e. 50 and60 wt %). Three different lengths of banana fiber are used, while keeping the length of the glass fiber constant. The detailed composition and designation of composites are shown. A releasing agent is used on the mould release sheets to facilitate easy removal of the composite from the mould after curing. The entrapped air bubbles (if any) are removed carefully with a sliding roller and the mould is closed for curing at a

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temperature of 30°C for 24 h at a constant load of 50 kg. After curing, the specimens of suitable dimension are cut using a diamond cutter for mechanical tests as per the ASTM standards. The composition and designation of the composites prepared for this study are listed in the following table. The samples have been prepared by varying the fiber length and fiber loading for the two fibers.

SAMPLE	MATRIX	MATRIX	REINFORCEMENT
	EPOXY	POLYESTER	SISAL FIBRE
BLACK	50%	-	50%
BLACK	-	50%	50%

Curing process

Curing at high temperature has the added advantage that it actually increases the end mechanical properties of the material. And many resin systems will not reach their ultimate mechanical properties unless the resin is given this 'Postcure'. This posture process involves increasing the laminate temperature after the initial room temperature cure, which increase the amount of cross linking of the molecules that can take place. To some degree this posture will occur naturally at warm room temperatures, but higher properties and shorter posture times will be obtained if elevated temperatures are used.

IV. FIBER AND RESIN

4.1 MECHANICAL PROPERTIES TEST

These mechanical tests are mainly used to find modulus of rigidity, young's modulus, impact strength and hardness of specimen. Using the above specimen we have to conduct the mechanical test is explained below.

MECHANICAL PROPERTIES TEST

1. Tensile strength.
2. Flexural strength.

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3. Impact strength test
   (i) Charpy test.

4.2 TENSILE TESTING OF COMPOSITES

The tension test was performed on all the three samples as per ASTM D638 test standards. The tension test is generally performed on flat specimens. A uni-axial load is applied through the ends. The ASTM standard test recommends that the length of the test section should be 100 mm specimens with fibers parallel to the loading direction should be 11.5 mm wide.

The main product of a tensile test is a load versus elongation curve which is then converted into a stress versus strain curve. Since both the engineering stress and the engineering strain are obtained by dividing the load and elongation by constant values (specimen geometry information), the load-elongation curve will have the same shape as the engineering stress-strain curve. The stress-strain curve relates the applied stress to the resulting strain and each material has its own unique stress-strain curve

4.3 FLEXURAL TEST

To find out the flexural strength of the composites, a three point bend test is performed using Instron 1195. The cross head speed was taken as 10 mm/min and a span of 30 mm was maintained. The strength of a material in bending is expressed as the stress on the outermost fibers of a bent test specimen, at the instant of failure. In a conventional test, flexural strength expressed in terms of MPa .

Flexural strength, also known as modulus of rupture, bend strength, or fracture strength a mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load. The transverse bending test is most frequently employed, in which a rod specimen having either a circular or rectangular cross-section is bent until fracture using a three point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of rupture.

The two types of flexural testing are 3-point for a concentrated load or 4-point for a distributed load and the type of test used depends on the material or design being tested. Mechanical testing equipment companies provide flexural bend testing machines, equipment, and systems designed for measuring the properties of adhesives, metals, plastics, composites, medical devices, rubbers, concrete, wood, polymers, and other materials and designs.

4.4 IMPACT TEST

It was performed to determine the energy absorbed by the material during fracture. This absorbed energy is a measure of given material toughness and acts as a tool to study temperature dependent brittle-ductile transition. Impact strength (charpy) was measured in an impact tester .

The Charpy impact test, also known as the Charpy v-notch test, is a standardized high strain-rate test which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's toughness and acts as a tool to study temperature-dependent ductile-brittle transition. It is widely applied in industry, since it is easy to prepare and conduct and results can be obtained quickly and cheaply. A major disadvantage is that all results are only comparative.

The standard specimen is ASTM D-256. The dimension of the specimen is 12.7×12.7×3mm

The results from The tests are given below:

The tensile strength of Sisal epoxy resin and sisal polyester are 74.35 MPa and 41.03MPa at 0.57 KN and 0.66KN respectively.

5.1 DESIGN AND PROPERTIES OF STEEL BUMPER

PROPERTIES OF STEEL BUMPER

The present automobile industries are using the steel bumper of AISI 4000 standard material for steel bumper manufacturing. The bumper thickness will vary depending up on the require weight of bumper. If

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we can reduce the weight of the bumper, automatically the engine efficiency and mileage will increase. The AISI 4000 steel bumper is having the yield strength of 275-410 M pa and the poison's ratio of 0.270-0.300. The izod and charpy impacts are 9 to 15.

TABLE 1 : CONTENTS OF AISI 4000 STEEL

CONTENTS	PERCENTAGE
Carbon, C	0.0500-1.29%
Chromium	0.300-3.330%
Iron	91.9-98.9 %
Manganese	0.300-3.00
Nickel	0.650-3.80%
Phosphorous	0.0200-0.0400
Silicon	0.150-1.05%
Molybdenum	0.0800-0.75

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TABLE2: PARAMETERS OF ANSYS FOR STEEL AND COMPOSITE SANDWICH STRUCTURE

Analysis type	**Static nonlinear**
No. Of nodes	17840
No. Of element	5828
Element size	10 mm
Mesh type	Quadrilateral

The total volume of the steel bumper is (Vs) = 407662.9 mm3

Dimension of steel sample = 40 × 40 × 6

Volume of sample = 40 × 40 × 6 = 9600 mm3

Equivalent weight of sample = 77 gm

To find the number of parts= Total volume of steel/ volume of steel sample

= 407662.9/9600

= 42.464 parts

The total weight of steel bumper = 42.464 × 77

= 3269.42 gm

= 3.37 kg

5.2 DESIGN OF COMPOSITE BUMPER

We can understand from the result that the present steel bumper is having more strength than composite for its equivalent thickness. So, we are increasing the thickness of the composite from 2mm to 5mm. So we are

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going to apply the same load to the composite bumper also and find its deformation and equivalent stress also.

Weight reduced of sisal epoxy

=(3.37- 1.203)/3.37=0.6379=63.79%

Weight reduced by sisal polyester

= (3.37-1.22)/3.37 = 0.637

5.2.1 COMPOSITE DEFORMATION

Total volume of the composite bumper (VC) = 1019157.09

Dimension of sisal epoxy sample = 40 × 40 × 4.5

Volume of sisal epoxy sample = 7200 mm3

Equivalent weight of sisal epoxy sample = 8.5 gm

To find the number of part=Total volume of composite/volume of sample

=1019157.09/7200 =141.549

Total weight of sisal epoxy bumper = 14154.95 × 8.5

= 1203.09 gm = 1.203 kg

Dimension of sisal polyester sample = 40 × 04 × 6

Volume of sisal epoxy sample = 9600 mm3

Equivalent weight of sisal epoxy sample = 11.5 gm

To find the number of parts = Total volume of composite/volume of sample

=1019157.09/9600 =106.162

Total weight of sisal polyester bumper =106.162 × 11.5

= 1220.864 gm

7.4.2 SISAL POLYESTER

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VI. RESULT AND DISCUSSION

The results of various tests are given and the it is tabulated below. The bumper weight is been compared with sisal epoxy and sisal polyester. Not only the tensile strength of the bumper but also the flexural strength of the material is compared with steel.

TABLE 3: TEST RESULTS

	STEEL	SISAL EPOXY	SISAL POLYESTER
Dimension of sample	**40×40×6**	**40×40×4.5**	**40×40×6**
Volume	**9600 mm^3**	**7200 mm^3**	**9600 mm^3**
Equivalent weight	**77 gm**	**8.5 gm**	**11.5 gm**
Total volume of	**407662.9 mm^3**	**1019157.09 mm^3**	**1019157.09 mm^3**

bumper			
Total weight of bumper	**3.37 Kg**	**1.203Kg**	**1.22 Kg**
Charpy impact	**3.45 J**	**4J**	**4J**
Tensile strength	**-**	**74.3**	**41.01**
Flexural strength	**-**	**127.449**	**91.772**
Weight reduced	**-**	**64.30%**	**63.79%**

VII. CONCLUSION

The existing bumper impact beam is made up of steel can be replaced by polymer composite bumper plate with increase in thickness having same strength but less weight (35.69 % weight is reduced). And also the impact bumper plate made up of sisal fiber polymer composite plate can reduce its cost.

REFERENCES

[1] M. Elkington, D. Bloom, C. Ward, A. Chatzimichali & K. Potter, Hand layup: understanding the manual process in , Advanced Manufacturing: Polymer & Composites Science,

[2] Pinkie E. Zwane, Development of fabric using chemically-treated sisal fibres, autex Research Journal, Vol. 6, No 2, June 2006 © autex

[3] Prof. (Dr.) Anjali Karolia, Ms. Rasika N. Bhoj, A Comparative Study on The Effect of Chemical & Enzyme Treatments on the Softening of Sisal Fiber, International journal of scientific research, Volume : 5 | Issue : 2 | February 2016 • ISSN No 2277 - 817

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