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MECHANICAL BEHAVIOUR OF SISAL AND BANANA EPOXY REINFORCED NATURAL HYBRID COMPOSITE

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Abstract

The future of the world is going to be converting materials from ferrous and non-ferrous materials to composite materials. And most of the applications are used to utilize natural fibers compared to artificial fibers. Because the natural fiber has good strength and easily available. And also, natural fibers are non-corrosive, less in weight, nontoxic and nonabrasive. The natural fiber was used in heavy duty applications like ropes, roofs, packing materials and home applications. In this study, an epoxy based composite with sisal and banana fiber reinforcement was considered. Used to strengthen epoxy resin, banana fiber and sisal fiber are used to make composite materials. For the research work, three ratio of composite specimens have been developed. The ratio that has been taken is sisal 40% with banana 60%, sisal 50% with banana 50%, and sisal 60% with banana 40%. The different weight percentages of banana and sisal fiber added to the epoxy resin affect the mechanical behavior of the composites is investigated.

Keywords: Banana fiber, Sisal fiber, Epoxy resin.–

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1. INTRODUCTION

Most of the automobile, marine, aerospace and home appliance companies looking different materials to reduce weight, reduce cost, increase availability and pollution less materials. Natural fiber composite is an tradiationally used around world. It is highly used in the area of automobile body parts, heat resistant clothes, bullet-proofing, marine application and civil structures etc. Due to the composite properties of the elements used in the composition, it is widely used in the automotive, marine and aerospace sectors. When a material is used in a composition, its dominant characteristics are shown to be improved properties and a better substitute for the current material. Natural and artificial elements are mixed to form composite materials to achieve the composite dominant properties of each material. The generally used natural materials are banana, palm, sisal, coir fibers etc. Most of the artificial fiber materials are carbon, E-glass fiber, S-glass and Kevlar etc. The natural materials are easily available specified application. So in order to achieve the required properties some additional natural fiber will added with that fiber. Therefore, those items meet the criteria immediately. By combining two natural fibers and sharing the dominant properties of each component, composite materials provide superior results. This study laid the foundation for the strength of sisal and banana fiber composites. Adding banana with sisal will have an increased mechanical strength and its property because of the combination of the dominant property of sisal and banana natural composites.

1.1 COMPOSITE MATERIAL

Generally more than one material boneded with one to one and producing an composite materials. The both material esensially have unique physical or chemaical properities. The individual segments stay isolated and distinct inside the completed structure. Usually fiber based composite materials additionally needed one bonding agent named resin and hardener.

1.2 NATURAL FIBER

In recent years, natural fibers appear to be a viable alternative to expensive, non-renewable and abrasive synthetic fibers, which is why the availability of natural fibers is emphasized. Low cost, easy to produce and less pollution.

2. LITERATURE REVIEW

R. Baskar et al (2020): Composite materials are more advantageous than traditional materials (iron, steel, etc.) because of their light weight, better fatigue performance, and longer material life.

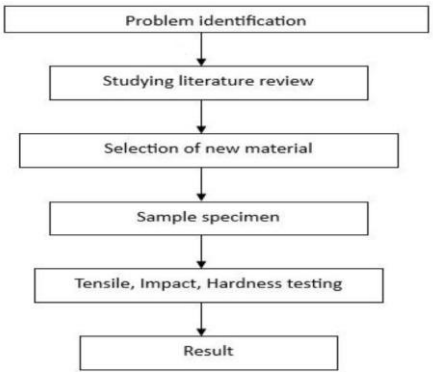
Akhil. A et al (2021): Composites are selected for relative strength, light weight and relative stiffness of a component. In order to differentiate the mechanical properties of alkali treated hybrid composite laminates, this paper analyzes both types. Different types of manufacturing processes also affect the properties of composite laminates. The results of several machine tests conducted support this. The final product of the work shows that banana/sisal laminate has superior flexural and impact strength when compared to other composite laminates. Alkali treatment also helps improve tensile properties. Fabrication is the most important step in making composite laminates using resin and hardener.

Furqan Ahmad et al (2014): The paper discusses the application of natural fiber composites and their properties in the automotive industry. Due to their environmental benefits, low cost and lightweight nature, natural fibers are replacing synthetic fibers inmany automotive parts.

Vijay Kumar Thakur et al (2014): Due to their unique intrinsic qualities such as biodegradability, easy availability, eco-friendliness, flexibility, easy processing and impressive physico-mechanical properties, natural cellulose fibers from various bio renewable resources have recently attracted the attention of the research community globally. Materials made of natural cellulose fibers are used in a variety of industries, from automotive to biomedical. Natural cellulose fibers are widely used as a reinforcing element in polymers to impart specific qualities to the finished product.

K.L. Pickering et al (2016): Research and innovation in the field of natural fiber composites (NFC) has grown rapidly recently. The advantages of these materials over other synthetic fiber composites, including low environmental impact, low cost, and support for their potential in a wide variety of applications, justify the attention. In an effort to expand the capabilities and applications of these types of materials, much work has been done on improving their mechanical performance.

3. METHODOLOGY



4. MATERIAL SELECTION

4.1 BANANA FIBER

The stems of the mature banana tree are used to make fiber. The stem was divided into different sizes as required and immersed in clean water for 20 days. After 20 days, it was dried in sunlight. A fiber extraction machine was then used to break the dried stalks. The extracted fibers were subjected to a four- hour treatment with 5% sodium hydroxide (NAOH) solution. After this wash tap water until natural PH is attained.

After that, rinse with tap water until the desired PH is reached. Dried at 105ºC for 24 hours to remove excess water and cut into desired size.

Fig. 1. Banana fiber

4.2 SISAL FIBER

Sisal fiber is one of the strongest fiber. It was extract from sisal leaves. The sisal leaf leaves was obtained from forest. The leaves was cleaned and cut into required length. Then this piece crushed by fiber extraction machine. After that dried leaves kept in sunlight for few days . Finally, fibers were fragmented and clarified using benzene-ethanol in a 2:1 liquid by volume ratio. NAOH solution prepared for soaking the shopped Fiber. The soking process were continued at 80ºC stirred for 90 minutes. Then is this fiber kept in container.

Fig. 2. Sisal fiber

4.3 EPOXY RESIN

For this research work epoxy resin based bonding agent used to create bond between two natural fiber names sisal and banana. Molecular weight of the epoxy resin is very low. This bonding agents usually available in liquid stage in epoxide groups. Trietha Tetra-amine hardner is used. Araldite AW 106, Hardener HV 953 U used as epoxy resin andhardener.

Fig. 3. Resin and HardenerProcedure:

- A blend of sisal and banana fiber is created using a hand lay up technique for this piece.
- Banana fiber and subtype sisal fiber were used to make the samples.
- Araldite resin and hardener are used to increase fiber bond strength.
- Hardener and resin are mixed in 1:1 ratio.

5. EXPERIMENTAL WORKS

DESCRIPTION OF HAND LAY UPTECHNIQUE

The prepared natural fibers copped into 3- 5mm length of pices. Equal amount of resin and hardener taken in container and mixed very well. After that chopped fibers put into the container and mixed. The mixed fiber and epoxy agent fine. And this mixed product pore into the mold for preparing plate. From this plate the specimens were cut for desired ASTM standards.

MATERIAL USED

Resins: Epoxy resin.
Natural fiber: Sisal, Banana

5.1 EXPERIMENTAL SETUPASTM STANDARDS

ASTM standard is an important engineering field controlling the material testing. This commetiee providing guidelines for investing the properties of materials. So, our research also following ASTM guidelines to test out prepared materials.

INTRODUCTION OF TESTING

Metallurgical testing is important to demonstrate the different qualities of metals and any defects that may develop during production or use.

6. RESULTS AND DISCUSSION

6.1 TENSILE TEST

In structural applivcations tensile strength of the material is very important to find oud the basic mechanical properties. Tensile test is an basic fundamental test in structural application. The specimen was prepared as per the ASTM standards. The load was gradually increased and find out the ultimate load of the specimen. From the ultimate load and specimen area the othe properties were calculated.

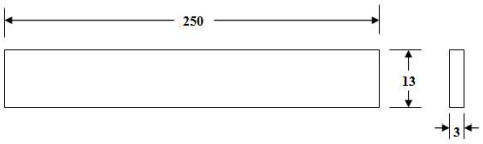


Fig. 4. Dimension of tensile test specimen

According to ASTM D638 standards, tensile test of sisal and banana hybrid composite is conducted using universal testing machine FIE-UTN 40. The machine can handle a maximum operating load of 400KN. UTM is shown in Fig. The sample size is 250x25x3 mm.

Fig. 5. Universal testing machine

Fig. 6. Tensile test specimen

The hybrid sisal and banana material was tested and the findings were calculated.

Table. 1. Tensile test results

S.No	Material		Specimen results	Tensile strength (Mpa)
	SISAL	BANANA		
1	40	60	27.30	26.09
			24.57	
			26.40	
2	50	50	32.25	30.76
			29.78	
			30.25	
3	60	40	38.60	38.04
			36.28	
			39.25	

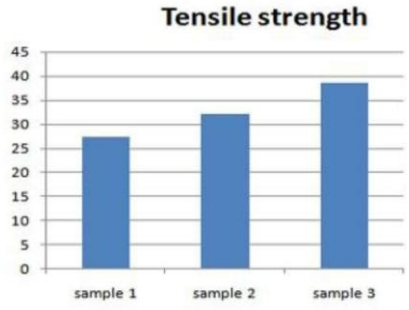


Fig. 7. Tensile test results

6.2 IMPACT TEST

The impact strength of the material defines the material resistance to shock or impact loads. For this test specimen placed on the work holding fixture. The pendulum with hammer is released from the certain height and it broke the specimen. During the hammer and specimen collision the energy is shown by the scale which placed on macine. That is called as impact test machine there is two types of impact testing machines widely used one is Izod and anotherone is Charpy.

Fig. 8. Impact test machine

The impact behavior of sisal and banana hybrid composite is shown in this test. Impact testing was performed using Izod Impact testing equipment as per ASTM norms. The specimen is prepared according to ASTM D256 criteria for this test. Impact tests were carried out on all samples and the results reported. A specimen for Izod impact testing is shown in the figure above with dimensions adhering to ASTM standards. Size of model: 65x13x3mm

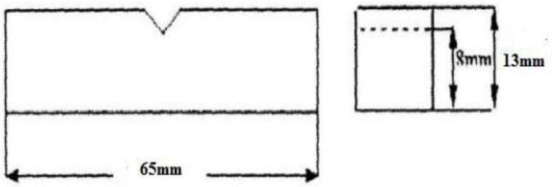


Fig. 9. Dimension of Impact test specimen

Fig. 10. Impact test specimenTable. 2. Impact test results

S. No	Material		Specimen results	Impact Strength (kj/m^2)
	SISAL	BANANA		
1	40	60	2.6	2.58
			2.35	
			2.8	
2	50	50	2.8	2.63
			2.65	
			2.45	
3	60	40	3.0	3.38
			3.25	
			3.90	

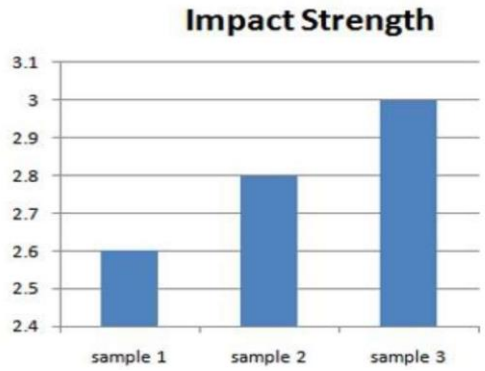


Fig. 11. Impact test results

6.3 HARDNESS TEST

Specimens for Rockwell-B hardness test were made according to ASTM D 785 criteria for composites. The ball indentation on the sample surface gives the hardness value.

Fig. 12. Hardness testing machine

ASTM D 785 standard is used to preparing the specimens for this test. For composites, 25x25x10 mm specimens were made for Rockwell-B hardness test.

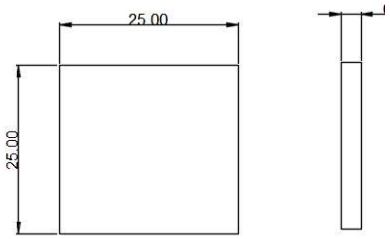


Fig. 13. Dimension of Hardness test specimen

Fig. 14. Harness test specimen Table. 3. Hardness test results

S.No	Material		Specimen	Hardness
	SISAL	BANANA		
1	40	60	94.30	94.18
			94.90	
			93.35	
2	50	50	95.2	95.48
			94.55	
			96.70	
3	60	40	95.80	94.81
			94.75	
			93.90	

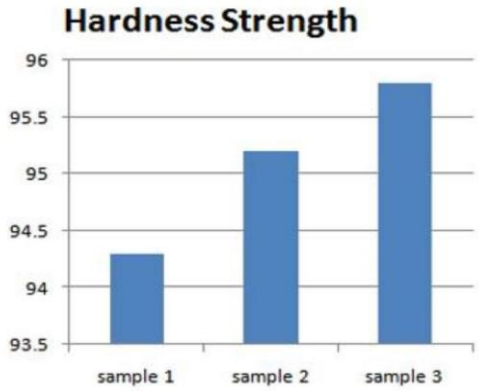


Fig. 15. Hardness test resultsCONCLUSION

As per the aim of these research banana and sisal fiber epoxy based composite material has been examined and the results were tabulated. The specimen for these testing made using hand lay up technique. Models were created in three different weight ratio of banana 40% & sisal 60%, banana 50% & sisal 50%, banana 60% & sisal 40%. Specimens were prepare for basic mechanical test of tensile, impact and hardness. From the test results table here the research concluded sisal 60% with banana 40% producing maximum strength compare than other propostions.

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