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Mechanical Properties of Short Natural Fibres (Banana, Hemp and Sisal) reinforced with Epoxy Hybrid Composite Material

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ABSTRACT

The natural origin of these materials causes, in general, a wide range of variations in properties depending mainly on the harvesting location and conditions, making it difficult to select the appropriate fibre for specific applications. Natural fibres as effectively as possible to produce good quality fibre- reinforced polymer composites for various engineering applications . And it able to replace the synthetic fibres that it has the eminent benefits of like low density, small manufacturing cost, its availability, ease of manufacture, low development energy, non-abrasive, worthy acoustic property, biodegradability, reasonable mechanical strength, renewability. In this research paper mechanical properties such as tensile and flexural of BHSHC were studied . Sample was prepared and tested in accordance to the ASTM standards. Hand layup method was adopted for fabrication of composite material.

Keyword-Banana, Hemp and Sisal Hybrid Composite (BHSHC)

I. INTRODUCTION

The utility of polymer based composites are increasing day by day. The polymer matrix composites (PMC's) are used in industries, automobiles, ships, structural applications etc. due to the advantages of high strength to weight ratio, ease to fabricate, complex shapes, low cost and good resistance to corrosion and marine [1]. Natural fibre composites include coir, jute, baggage, cotton, bamboo, hemp. Natural fibres come from plants. These fibres contain lingo cellulose in nature. Natural fibres are eco-friendly; lightweight, strong, renewable, cheap and biodegradable[2].The most primitive man-made composite materials were straw and mud combined to form bricks used for structural purposes [3].Different fibres can be used in polymer matrix to enhance the mechanical properties which includes synthetic fibre and natural fiber. Synthetic fibers like, carbon, glass or kevlar fibre are used in high strength application. But the cost involved in these composites is very high. On the other hand, natural fibers are very cost effective[4].The attraction in utilizing natural fiber, for example, distinctive wood fiber and plant fiber as support in plastics has expanded drastically throughout last few years[5].They can be also considered as homogeneous materials on a microscopic scale in the sense that any portion of it will have the same physical property[6]. 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[7].The development of natural fiber composite materials or environmentally friendly composites has been a hot topic recently due to the increasing

environmental awareness. Natural fibers are one such proficient material which replaces the synthetic materials[8].The application of natural fibers such as kenaf, jute, bamboo, flax and wood in fiber reinforced composites has become so important of late due to their high effective strength and stiffness, low cost, low production energy requirement[9].It was found that materials made of renewable resources like natural fibres embedded in a polymer matrix called biopolymers provide us good alternatives to synthetic fibre composites.[10] Natural fibres have many remarkable advantages over synthetic fibres. Nowadays, various types of natural fibres have been investigated for use in composites including flax, hemp, jute straw, wood, rice husk, wheat, barley, oats, rye, cane (sugar and bamboo), grass, reeds, kenaf, ramie, oil palm, sisal, coir, water hyacinth, pennywort, kapok, paper mulberry, banana fibre. [11] Sisal fibre has the characteristics of ideal substitute of asbestos for brake composites Biwa's et al. studied with coir reinforced epoxy composite and observed that mechanical properties dependent on the length of reinforcement fibre[12]. The Chemical and physical treatments of sisal fibre increases fibre strength and the adhesion between the fibre bundles and the matrix resulting in the improvement of mechanical properties, especially tensile properties of sisal laminates[13]. This study presents life cycle assessments of a side panel for Audi A3 car made from ABS co-polymer and an alternative design made from hemp fibre epoxy resin composite[14].

II. METHODS AND MATERIAL

Banana Fibre

*Banana fibre*s are eco-friendly former and women are extracting *fibre* from *banana* stem. Stronger than Jute, Shining & Softness are key features of *fibre*. Women are also making different kind of handicraft items from *banana fibre* .Banana fibre is a natural best fibre which has wide range of uses in handicraft product developments such as mat, rope and twines, but only 10% of its pseudo stem is being used for making products and remaining is waste or used as fertilizer. The production process for banana textiles is a sustainable, eco- friendly one. When grown in tropical areas, banana plants rarely require fertilizers or pesticides. The crops the fibres come from are often from smaller farms, in which the farmer owns the land. Banana paper is made from the extracted pulp fibres - banana yarn, or cloth is made by a slightly different process. Afterwards, the threads can be dyed or weaved. Green Banana Paper uses the banana paper to make wallets and weaves. One serving of banana contains 110 calories, 30 grams of carbohydrate and 1 gram of protein. Bananas are naturally free of fat, cholesterol, and sodium. Bananas provide a variety of vitamins and minerals: Vitamin B6 - 0.5 mg.

Figure 1(a)- Banana fibre before cutting

Figure 1(b)- Banana Fibre after cutting

Table No. 1 Chemical Compositions of Banana fibre [14]

Extractive (%)	10.5
Holocellulose (%)	80.5
Alpha-cellulose(%)	73.4
Lignin(%)	10.5
Ash(%)	2.0

Hemp Fibre

True hemp is a fine, light-colour, lustrous, and strong best fibre, obtained from the hemp plant, "cannabis saliva." It is a plant similar to jute, grown in many countries. Hemp fibres are one of the strongest and most durable among all of the natural textile fibres. Hemp fibre shows similar properties like all of the natural best fibre and excels in fibre length, durability, strength, absorbency, ant mildew and anti-microbial properties .hemp fibre is purchasing from Experts India Private Limited Gorgon West Mumbai. *Hemp*, or industrial *hemp* typically found in the northern hemisphere, is a strain of the Cannabis The best *fibres* can be used to make textiles that are 100% *hemp*, but they are commonly blended with other producing different ratios and *compositions* of terpenoids and cannabinoids.

Figure 2 (a)- Hemp Fibre before cutting

Figure 2 (b)- Hemp fibre after cutting

Cellulose	70%
Lignin	8-10%
Pectin	2.9%
Fat-Wax	0.9%
Mineral	1.8%

Table 2. Chemical compositions of Hemp Fibre[14]

Sisal Fibre

Plant Fibres - Sisal (Agave sisal Ana) Sisal is a hard fibre extracted from the leaves of sisal plants which are perennial succulents that grow best in hot and dry areas. Sisal is an environmentally friendly fibre as it is biodegradable and almost no pesticides or fertilizers are used in its cultivation. We purchasing sisal fibre from, Matlock Sisal Fibre Company Ltn have made a name for itself in the list of top suppliers of Paper & Paper Boards. We used 80 gm sisal fibre in mixture of hemp and banana. The length of sisal fibre is between 1.0 and 1.5 m and the diameter is about 100–300 μm. The fibre is actually a bundle of hollow sub-fibres. Their cell walls are reinforced with spirally oriented cellulose in a hemi-cellulose and lignin matrix.

Figure 3(a)- Sisal Fibre before cutting

Figure 3(b)- Sisal fibre After cutting

Table 3 Chemical compositions of sisal fibre[14]

Cellulose	65%
Hemicellulose	12%
Lignin	9.9%
Waxes	2%
Total	100%

Epoxy Resin

Epoxy is an organic compound. It is made up of chains of carbon linked to other elements such as hydrogen, oxygen, or nitrogen. The term *epoxy* can also be used to refer to the *epoxy* resins that appear after curing. First all we epoxy is procured by Union Carbide Corporation, New York .Araldite LY 556 epoxy manufactured by Huntsman. Epoxy Hardener as preserving agent The proper mixing of epoxy with hardener HY 951 provide better performance. High adhesive strength and high mechanical *properties* are also enhanced by high electrical insulation and good chemical resistance. *Epoxies* find uses as adhesives, caulking compounds, casting compounds, sealants, varnishes and paints, as well as laminating *resins* for a variety of industrial applications.

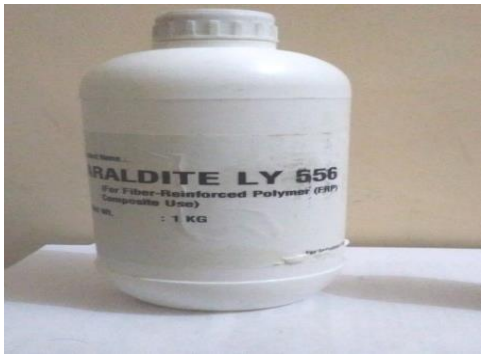

Figure 4(a)- Araldite LY 556

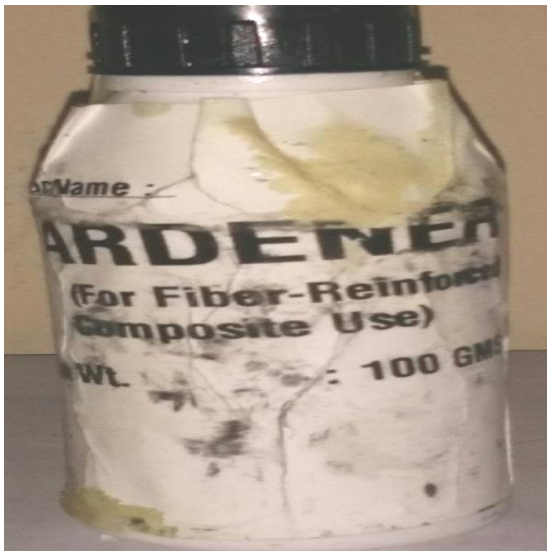

Figure 4.(b)- Hardener HY 951

FABRICATION

A wooden frame of dimension (350x250x6) mm is made . Short fibre of 100gm banana ,100gm Hemp and 80gm sisal were mixed in matrix .Matrix used is Araldite LY556 and Hardener HY 951 in the ratio of 10:1. Wax ia applied on both the sides of mould for easy removal of composite material. The mixture of short natural fibres and resin which was thoroughly mixed is finally poured in the frame cavity . A pointed tool is used for removal of trapped air bubbles .The mould is closed and a fixed load is applied through the C-clamp and is left for the 48 hours at 55% humidity at room temperature for curing.

Figure 5- Wooden frame

Figure 6- Mould

Finally, the hybrid composite sheet is prepared having a dimension of (350×250×6) mm. It is characterized by the different mechanical parameters like tensile and Flexural test. It is cut by the diamond tip hand cutter.

Figure 7- Final sheet

Figure 8- Side view of the final sheet

III. RESULTS AND DISCUSSION

TESTING AND RESULT

Tensile Test

In universal testing machine (UTM) the tensile test was carried out at a speed of 50mm per minute the standard followed for tensile testing was ASTM D-638.Tensile test deals with the maximum amount of the stress sustain by the material before and after fracture. The working range of the specimen is max. 100 KN accuracy of the machine is ±0.66% and the purpose of the machine is to find out the mechanical properties of the specimen The testing was carried out on CIPET, Lucknow.The specimen hold by the grip and load applied until the failure occurs shows in figure before and after holding the specimen in the UTM machine. Fig.9(a) &9(b) shows the digital UTM machine before and after holding the specimen in the jaw.

Figure 9(a)- Digital UTM

Figure 9(b)- Specimen fixed hinged job

Fig.10(a)&10(b) shows the tensile test of the specimen before and after fracture respectively. It shows breaking obtained at the neck point .figure shows very clearly of the working of specimen.

Figure 10(a)- Tensile Specimen before Fracture

Figure 10(b)-Tensile Specimen after Fracture

Result

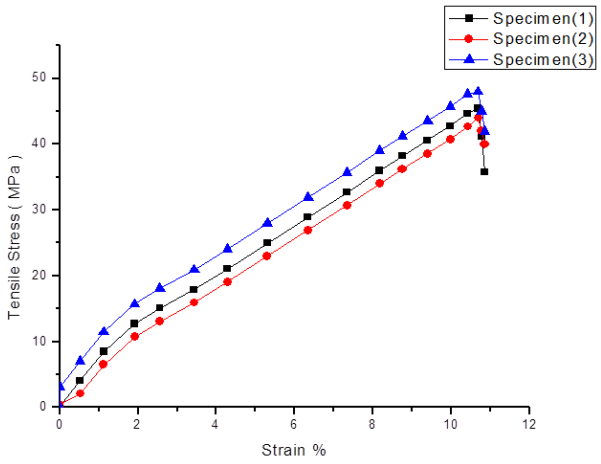

Figure 11- Stress strain curve of BHSHC

Obtained value from curve:

Tensile strength of specimen-40.43 MPa
Young modulus-551.87 MPa

Flexural Test

The flexural test is carried out in a Universal Testing Machine and it is made by INSTRON, USA and there is a code no. PTC/083/ME. Its working capacity maximum 100 kN and accuracy is ±0.066%. It is used for measuring mechanical property specimen. The Flexural test is carried out in a UMT, no samples cut in accordance with ASTM D-790 standard the testing procedure is as per the three-point bending test by placing the specimen on the Universal Testing Machine and applying load till the specimen being fracture and break Results is compared with other specimen results , and flexural strength of the material is identified. The samples before and after test presented in Figure

Figure 12- Flexural specimen fixed in UTM vice

Figure 13(a)-Flexural specimen before fracture

Figure 13(b)- Flexural Specimen after Fracture

Result

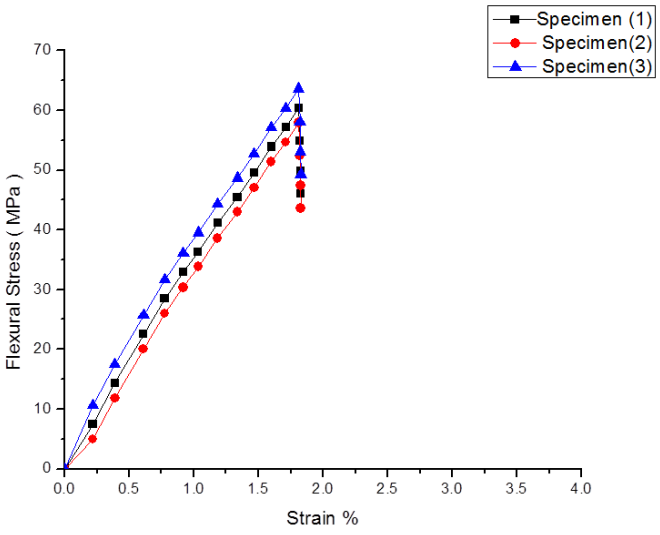

Figure 14- Flexural Stress strain curve of BHSHC

Obtained value from curve:

Flexural strength of specimen-60 MPa

Young modulus-3624.6 MPa

IV.CONCLUSION

This particular work is carried out to find out the mechanical strength of banana, hemp, sisal fibre and natural hybrid fibre reinforced epoxy composite. Various Mechanical tests are perform as ASTM standards.

(1)This works shows that successful fabrication of homogeneous composite laminates is by hand lay-up methods.

(2)There is 14.16% increase in ultimate tensile strength of BHSHC composite (60MPa) by adding banana, hemp and sisal fibre with epoxy.[15]

(3)The flexural strength value of the hybrid fibre reinforced composites is reasonably good.

(4) The various test results of the all hybrid composite infer that banana, hemp and sisal fibre is showing good mechanical strength having 40-50% higher value to the least performing flax glass composites materials.

(5) The tensile strength of the specimen is found in the results 40.43.16 N/mm² from the ASTM standard machine.

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