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A Review on Composition and Properties of Bagasse Fibers

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Abstract—

In recent years, the natural fibres have attracted substantial importance as potential structural material. Natural fibres are very fast replacing the traditional manmade fibres as reinforcements they have several advantages over manmade fibres. The abundant availability of natural fibre in India such as Jute, Coir, Sisal, Pineapple, Ramie, Bamboo, Banana, Bagasse etc. gives attention on the development of natural fibre composites primarily to explore value-added application avenues .Thousands of tons different crops are produced but most of their wastes do not have useful utilization. These different crops waste can be used with polymer to form natural fiber polymer composites for many applications. The wastage is used to prepare fiber reinforced polymer composites for commercial use. Natural fiber is used as an alternative resource to synthetic fibres as well as reinforcement for polymer composite materials and the manufacturing is inexpensive, renewable and environment friendly. Natural fibers have low cost, low density and low durability as compare to synthetic fibers but with the help of fiber treatments, mechanical properties of natural fibres are improved. This review discuss about the use of bagasse fibre and its current status of research. Bagasse fiber is a residue of a sugarcane milling process. The present use of bagasse is mainly as a fuel in the sugar cane mill furnaces.

Index Terms— Bagasse fibres, Composite material, Natural fibers, Sugar can

1 INTRODUCTION

Composite materials are also called composition materials or shortened to composites. Composite materials are materials made from two or more constituents' materials with significantly different physical or chemical properties. When we combined these materials, produce a material with different characteristics from the individual components. Composites are materials that comprise strong load carrying material is known as reinforcement and imbedded in weaker materials is known as matrix. Reinforcement provides stiffness and strength, helping to support structural load**.** Bagasse is bio product of sugar cane fiber which is left after the juice has been extracted from the sugar cane. Bagasse fibers are natural fiber products and it biodegrades in 25-65 days. Bagasse fibers are the bast fiber like as banana fibers. It consists of water, fibers and small amounts of soluble solids. Percent contribution of each of these components change according to the maturity variety, harvesting and the efficiency of the crushing plant. For each 10 tons of sugarcanes crushed, a sugar factory produced nearly 3 tons of wet bagasse. Bagasse is mainly used as a burning raw material in the sugar cane mill furnaces. Bagasses have low caloric power, which makes this a low efficiency process. Approximately 9% of bagasse is used in alcohol (ethanol) production. Ethanol is not a good replacement for the fossil fuels, but it is an environmentally friendly fuel. Ethanol is a very versatile chemical raw material from which a variety of chemicals can be produced. There exist an excellent opportunity in fabricating bagasse based composites towards a wide array of applications in building and construction such boards and blocks as reconstituted wood, pulp, flooring tiles etc. These pulps are suited for generic printing and writing paper as well as tissue product but it is widely used for boxes and newspaper production. Bagasse fibers are short they result in paper with enhanced printing quality and also improved paper porosity.

Fig. 1.1 Bagasse Fiber

2.COMPOSITION AND PROPERTIES OF BAGASSE FIBRES

Table1 shows the classification of the selected plant fibers. These fibers could easily be used in the composite manufacture.

Table 1: Production details of fibers, origin of bagasse fibers

Botanical name	Gramineae Saccharum officinarum L
Palnt origin	bast
Production per metric ton	135

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Table 2 is those of the single cell fibers i.e., the physical properties of bagasse fibers. Fibers with the highest aspect ratio will exhibit highest tensile properties provide high surface area which are advantageous for reinforcement purposes.

Table 2: Physical properties of the bagasse fibers

Dia(μm)	10-34
Length(mm)	0.8-2.8
Aspect Ratio(l/d)	76
Moisture content (%)	49

Table 3 shows the chemical composition of bagasse plant fibers, and their physical properties. It is noted that cellulose is the main constituent of plant fibers followed by hemi-celluloses and lignin interchangeably and pectin respectively. Cellulose is also the reinforcement for lignin, hemi cellulose and Pectin.

Table 3: Chemical composition of bagasse fibers

Cellulose (%)	45-55
Hemi cellulose (%)	20-25
Lignin (%)	18-24
Pectin (%)	0.6-0.8
Ash (%)	1-4
Extractives (%)	1.5-9

Table 4 shows mechanical properties of bagasse fibers, by which we use fibers as reinforcement for a good mechanical properties of composite materials.

Table 4 Mechanical properties of bagasse fibers

Tensile Strength (Mpa)	180-290
Young's Modulus (Gpa)	15-19
Failure Strain (%)	1-5
Density (Kg/m3)	880-720

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3. LITERATURE REVIEW

Nilza G. Jústiz-Smith et al [1] study on Potential of Jamaican banana, coconut coir and bagasse fibers as composite materials. It presents an evaluation of the alternative use of three Jamaican natural cellulosic fibers for the design and manufacturing of composite materials. The natural cellulosic fibers under investigation were bagasse from sugar cane (saccharum officinarum), banana trunk from the banana plant (family Musacae, genus Musa X para disiaca L), and coconut coir from the coconut husk (family Palm, genus coco nucifera). Fibre samples were subjected to standardized characterization tests such as ash and carbon content, water absorption, moisture content, tensile strength, elemental analysis and chemical analysis. The banana fibre exhibited the highest ash, carbon and cellulose content, hardness and tensile strength, while coconut the highest lignin content.

E.F. Cerqueira et al [2] evaluated the effect of chemical modification on mechanical properties of sugarcane bagasse fibre/polypropylene composites because the natural fibers shows some drawback such as the incompatibility between fibers and polymer matrices, the tendency to form aggregates during processing and the poor resistance to moisture reduce the use of natural fibers as reinforcement in polymers. To overcome this problem several methods of surface modification is used to improve fibers and polymer matrices compatibility. like chemical treatment one of chemical treatment were done in this paper in which composite were pre-treated with 10% sulphuric acid solution, followed by delignification with 1% sodium hydroxide solution. These fibers with different volume fraction (5 to 20%) mixed with the polypropylene in a thermo kinetic mixer. The mechanical properties were evaluated by means of tensile 3-point bending and impact tests. In addition fraction analysis via SEM (secondary electrons mode) was performed. Results shown improve the tensile, flexural and impact strength of composites in comparison to the polymer pure.

Gope P.C et al [3] developed a new composite by using fly ash and bagasse fibre. SEM analysis was used to determine the microstructure of this composite material. That showed the uniform distribution of fly ash and bagasse fibre over the matrix. Then this fly ash bagasse fibre composites with epoxy resin was compared with ordinary bagasse fiber and found that the hardness of the composites with fly ash- bagasse shown higher harness than bagasse fiber composite.

Isiaka Oluwole Oladele et al [4] investigated that when bagasse fiber with different volume fraction (5, 10, 15 and 20%). Mechanical testing was carried out on the samples. And it was observed that 10 wt% bagasse fibre loading gave good response against various test, bagasse particulate fibre in the range of 5-10wt% gave the optimum results than other volume fraction (15 to 20w%).

J.L. Guimaraes et al [5] studies of the processing and characterization of corn starch and its composites with banana and sugarcane fibers from Brazil. This paper presents results on the characterization of corn starch by X-ray powder diffraction and thermal analysis, as well as processing and characterization of starch–banana/sugarcane bagasse fiber composites. X-ray diffraction studies revealed that the starch sample belongs to the A-type, common in cereals. Thermal analysis showed good thermal stability for making composites, while fractographic studies of 70 wt. % starch and 30% glycerol matrix revealed cracks between smooth and rough surface and dimples in rough regions, suggesting the sample was ductile. The composites of this matrix with banana and bagasse fibers prepared by compression molding showed more homogeneous composites with crude glycerin and structural changes in both the fiber composites, while their morphology was dictated by the properties of the fibers rather than by those of the matrix. Improvements in tensile properties were observed in these composites over those of the matrix, which are explained based on fractographic observations.

D. Chandramohan et al [6] study on natural fibers, this review paper discuss about worldwide review report on natural fibers and its applications and also concentrates on biomaterials progress in the field of orthopaedics. An effort to utilize the advantages offered by renewable resources for the development of biocomposite materials based on bio epoxy resin and natural fibers such as Agave sisalana; Musa sepientum; Hibiscus sabdariffa and its application in bone grafting substitutes.

D. Verma et al [7] give a review on bagasse fiber composites, this review discusses the use of bagasse fibre and its current status of research The possibility of surface chemical modification of bagasse fibers have been extensively used in a wide variety of application, e.g., packaging, furniture's and electronic display materials. The present contribution defines some selected works in the field of bagasse fibers.

Punyapriya Mishra [8] developed bagasse composites with different volume fraction (10, 15 and 20%) and wear behaviour were predicted with the help of a mathematical model. And experiments were conducted using full factorial design in the design of experiments (DOE) on pin-on-disc type wear testing machine against 400 grit size abrasive paper. A second order polynomial model developed for the prediction of wear loss. The model was developed by response surface method(RSM) analysis of variance technique at 95% confidence level was applied to check the validity of the model. The effect of volume percentage of reinforcement, applied load and sliding velocity on abrasive wear behaviour was analysed and found that the relationship of abrasive wear loss with fibre concentration, applied load and sliding velocity successfully obtained by using RSM at 95% confidence level. But this model is only valid within the selected experimental parameters of fiber concentration, applied load and sliding velocity.

Punyapriya Mishra et al [9] investigated the effect of impingement angle and particle velocity on the solid particle erosion behaviour of different volume fraction of bagasse fiber reinforcement polymer composites (BFRPCs). The erosion wear is evaluated at different impingement angles 30^0 to 90^0 at four different velocities of 48, 70, 82 and 109 m/s. The erodent used is silica sand with the size range 150-250μm of irregular shape. This experimental work done on air jet erosion test machine and found that with the increase in fiber content in the composite, its hardness value improves although the increment is marginal and erosion rate also increase with different fiber loading tested as a function of angle of impingement at different impact velocities(v=48,70,82,109m/s respectively). It is also observed that the erosion rate increases with the impact and attains a peak value (α_{min}) at 90^0. The composites exhibited a maximum erosion rate at an impingement angle of 90^0 under this experimental condition indicating brittle behaviour.

N.Vijay Sai et al. [10] Studied about the transverse vibration analysis of hybrid sisal-bagasse fabric reinforced epoxy composites. In this analysis, a frequency domain model was used along with frequency response function measurements obtained from the plate. These measurements are made using a fast Fourier technique (FFT) based spectrum analyser. Natural frequency damping factor and mode shapes are obtained from the composites. The main purpose of this paper was to determine the damping factor and mode shapes for a cantilevered rectangular symmetric plate of hybrid sisal-bagasse fabric reinforced epoxy composite with fabric reinforced epoxy composite with fiber orientation ($+90^0/+45^0/0^0/-45^0/-90^0$) using a fast Fourier technique based spectrum analyser. To experiment work two type of composites were prepared by hand lay-up technique. One was a hybrid composite (sisal/bagasse fibre reinforced epoxy composite) and another was ordinary sisal composite. Both composite had same dimensions (300*300*3.8). After experimental work obtained dynamic behaviour of composite under various natural frequencies and observed that the average damping factor obtained for fundamental frequency of hybrid sisal-bagasse composite is 1.15 times greater than the sisal composite. However the damping factors of hybrid sisal bagasse reinforced epoxy composites are than that of conventional composites and monolithic materials. It also observed that the average damping factor obtained for fundamental frequency of hybrid sisal-bagasse composite is 1.15 times higher than that of sisal composite. Hybrid sisal bagasse fabric reinforced epoxy composites possess good damping factor as compared to conventional composites. Therefore these composites can be used as vibration absorbing materials in certain applications such as automobile industries, for construction roofing material and for indoor application.

Punyapriya Mishra et al. [11] investigated abrasive wear behaviour of bagasse (20w %) fibre reinforcement polymer composite in different orientation normally parallel orientation (PO), anti-parallel orientation (APO) and normal orientation. By using two body abrasive wear tester. It was observed that the abrasive wear of all 3 orientation bagasse fibber composites follow the following trends: $W_{NO}<W_{APO}<W_{PO}$. This experimental work was done with various loads and abrasive grit size and it was found that increase of load and grit size wear rate increase.

Ali Varshoee et al. [12] investigated the feasibility of fiber using with cement. Due to this purpose, the effect of two bagasse fiber loads (4, 10 w%), three levels of calcium chloride as facilitator (5, 7.5 and 10% per dry weight of cement) and two different types of port land cement (type II and V) on physical and mechanical properties of specimens those were tested. the results after testing were analysed with three variables by a fully randomized process as factorial experiments as well as dankan test and variance analysis technique. The result indicated that the best conditions reported for flexural strength, modulus of elasticity, internal bond and minimum thickness swelling were 4% fibre, 7.5% calcium chloride and type II cement.

4. REVIEW OBJECTIVE

The present review concentrates on the properties and chemical composition of bagasse fibers. It is challenge to the creation of better materials for the improvement of quality of life with better mechanical properties. The present review also focuses on the physical properties, mechanical properties, fiber types, chemical composition of bagasse fibers. The objective of the present study is to utilize the advantages offered by renewable resources for the development of composite materials based on bagasse. It is challenge to the creation of better materials for the improvement of quality of life with better mechanical properties. The present review also focuses on the utilization of bagasse fiber as a green bricks.

5. CONCLUSION

The main objective of the present review is to explore the potential of the bagasse fiber polymer composites and to study the mechanical properties of composites. This review reports the use of bagasse fiber, as reinforcement material in polymer matrix. This also helps to providing knowledge to escalate further research in this area. Any natural fiber such as sisal, banana, bagasse, coir etc. used as reinforcement, gives good result as compared to the man-made fibers such as glass fiber, carbon fiber etc. If we talk about the future of bagasse fibre is very bright because they are cheaper, lighter and environmentally superior to glass fiber or other synthetic fiber composites in general. If we talk about the future of bagasse fibers, are very bright because they are cheaper, lighter and environmentally superior to glass fiber or other synthetic fibers composites in general. Hence, with this back ground, it is concluded that, the composites stand the most wanted technology in the fast growing current trend.

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