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PROCESSING AND CHARACTERIZATION OF JUTE FIBER REINFORCED POLYMER COMPOSITES WITH FLY ASH

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***Abstract*—Natural fiber reinforced bio-degradable composites are good alternative for conventional materials. Natural fibers have the advantage that they are renewable resources and have marketing appeal, cheaper in cost, environmental friendly and biodegradable. In the present research, composites were made using short Jute fibers and fly ash blended with epoxy resin. Application of composite materials to structures has presented the need for the engineering analysis, the research focuses on the fabrication of polymer matrix composites by using natural fibers and calculating its material characteristics by conducting tests like tensile test, compression test, flexural test, hardness test, water absorption test, impact test, density test, etc. The effect of different lengths of jute fiber content with Flyash has also determined. Also matrix fiber interface were studied using SEM.**

Key words: Composite; Jute fiber; SEM;

I. INTRODUCTION

Stiffer and help it Light, strong and corrosion-resistant, composite materials are being used in an increasing number of products as more manufactures discover the benefits of these versatile materials. The strength and lightness of composites has made them particularly attractive for transportation. Venkateshwaran et al made an review and apart from being lighter and stronger, they can offer better performance than metals at high temperatures and do not develop potentially dangerous weaknesses such as fractures and fatigue. Composite properties (e.g. stiffness, thermal expansion etc.) can be varied continuously over a broad range of values under the control of the designer and careful selection of reinforcement type. Most composites consist of fibers of one material tightly bound into another material called a matrix, whereas the fibers make the matrix strongeresist cracks and fractures. Fibers and matrix are usually (but not always) made from different types of materials. The fibers are typically glass, carbon, silicon carbide, natural fibers or asbestos, while the matrix is usually epoxy, plastic, metal, or a ceramic material.

A composite material consists of two phases. It consists of one or more discontinuous phases usually harder and stronger embedded in a continuous phase usually more ductile and less hard thereby improves the overall mechanical properties of the matrix. Rohatgi et al characterized the properties of composites are strongly dependent on the properties of their constituent materials, their distribution and the interaction among them. In this research, Jute fiber reinforced composite and jute fiber with fly ash blending were made and tested for its mechanical properties.

II. LITERATURE SURVEY

Kiran et al made the composite with Sun Hemp, Banana and Sisal Fiber for improving the mechanical strength of the composite materials. Haneefa et al concentrated on the tensile and the flexural test on the composites reinforced with banana and glass fibers. Mubashirunnisa et al conducted experimentation with the same banana and glass fiber and also included Nanochitosan polymer to improve the properties. Merlini et al. have studied the effect surface treatment on the chemical properties of banana fiber and reported that treated banana fiber give higher shear interfacial stress and tensile strength when compared with the untreated fiber. Palanikumar et al made a hybrid composite with glass, sisal and jute. Dhieb et al. have studied about the surface and sub-surface degradation of unidirectional carbon fiber and have given many conclusions such as under sliding in demineralised water, the most simple degradation was detected on sliding in anti-parallel direction. Shankar et al. have studied and reported that the ultimate tensile strength value maximum at 15% and then decreases with increasing in fiberstarting from 15% to 20%. They also reported that the flexural strength value decreasing from 5% to 10% (87.31 MPa) and after that the value increased from fiber. Khalil et al tested the bio composite reinforced with bamboo. Sumaila et al. have investigated the influence of fiber length on the mechanical and physical properties of nonwoven short banana, random oriented fiber and epoxy composite and they described that the tensile properties and percentage elongation of the composite attained a maximum in composite fabricated from 15 mm fiber length. The banana fiber characteristic depends on the diameter, mechanical characteristic and the effects of the stresses performing on the fracture morphology. The stress-strain curves for changed strain rates were found and fractured surfaces were inspected by SEM by Mukhopadhyay et al. Pothan et al. have investigated on the influence of fiber content and length on short banana fiber reinforced polyester composite material. Laban et al. has studied on the physical and mechanical behaviour of banana fiber reinforced polymer composite and noticed that kraft mashed banana fiber material has better flexural strength.

Prasannaand Subbaiah reported that composites material having 20% treated fiber loading possess maximum values for above-mentioned properties than untreated composites, 10% and also 30% treated fiber composites. Satyanarayana et cl carriedout the research in composites and the interfacial area having main role in influential the strength of polymer material since fiber procedures a separate interface with the matrix. The treated banana fiber demonstrated higher shear stress and tensile strength when contrasted with the untreated fiber, showing a solid association between the treated strands and the polyurethane matrix. The hybridization of these reinforcement in the composite shows more terrific flexural quality when contrasted with singular kind of characteristic strands strengthened composites. All the composites shows expand in flexural quality in longitudinal heading. Comparable patterns have been watched for flexural modulus, entomb laminar shear quality and break burden values. Kulkarni et al have evaluated the mechanical, chemical and physical behaviour and banana fiber reinforced with epoxy composite. Many studied and compared of effect of treated and untreated banana fiberreinforced with thermoplastic and thermosetting polymer. Joseph et al. studied and compared the mechanical behaviour of phenol formaldehyde composites which was reinforced with glass fiber and banana fiber. Selzer et al. studied the carbon fiberreinforced polymer composites and reported that the brittle materials demonstrate a lot of delamination's also interlinear splitting throughout weariness. The disappointment of this material was dictated by a restriction of disappointment. This implies that in composites with aexceptionally intense grid and great fiber-network bond, various splitting, which ingests a higher measure of vitality, is anticipated, with the goal that at last confined disappointment happens at easier levels than anticipated. There is wide range of research in these fields; many researchers have investigated the natural fiber composite reinforced with various type of polymer. The banana and glass fiber bio-composites may be fabricate for outdoors and indoors applications wherever high strength is not necessary, additionally it can considered as the replacement to wood materials and protect the forest resources.

Kularni et al. have studied the mechanical properties of banana fiber based epoxy composite. Aziz et al used the bamboo fiber as the reinforcement instead of the steel rods for the structures and found the results are found satisfactory. Mohini et al conducted experimentation of role of carbon in the natural fiber and the recycling feasibility to reduce the environmental pollution. Shibata et al made an attempt to fabricate a light weight composite material with good properties, so they identified kenaf and polypropylene fibers. Madhukiran et al used the banana and pineapple fibers as the reinforcement for the epoxy matrix and concluded that the natural fibers are having good mechanical strength. There are many reports available on the mechanical and physical properties of natural fiber reinforced polymer composites, but, the effect of fiber length on mechanical behaviour of banana fiber reinforced polymer composites is scarcely been reported. To this end, the current work has undertaken with the objectives to investigate the mechanical properties of banana fiber based epoxy composites.

III. JUTE FIBER REINFORCED COMPOSITE

The mechanical behaviour of a natural fiber based polymer composite depends on numerous factors, for example, fiber length and quality, matrix, fiber-matrix adhesion bond quality and so forth. The strong interface bond between fiber and matrix is paramount to show signs of improvement mechanical properties of composites.

Jute fiber is obtained from two herbaceous annual plants such as Corchoruscapsularis and Corchorusolitorius. The jute plant grows six to ten feet in height and covered with thick bark, which contains the fibers having multi-celled in structure with the wall made up of a number of layers. The jute fiber possesses moderately high specific strength and stiffness. Therefore, it is suitable as reinforcement in a polymeric resin matrix. However, it exhibits considerable variation in diameter along with the length of individual filaments. The properties of the fiber depend on factors such as size, maturity and processing methods adopted for the extraction of the fiber. Properties such as density, electrical resistivity, ultimate tensile strength and initial modulus are related to the internal structure and chemical composition of fiber. In order to further enhance the mechanical properties and to overcome the limitations in the jute fiber, Jute fiber also reinforced with jute.

Fly ash is a finely divided residue resulting from the combustion of coal having spherical glassy particle ranging from 1 to 150 µm in diameter. The experimentation had conducted with class F fly ash obtained by burning anthracite and bituminous contains less than 10% lime (CaO). Finally all these items need to embedded into epoxy resin for proper bonding.

Epoxy resins traditionally are made by reacting epichlorohydrin with bis-phenol A, which are linear polymers that cross-link, forming thermosetting resins basically by the reaction with the hardeners.

The extracted Jute fibers were subsequently sun dried for eight hours then dried in oven for 24 hours at 105° C to remove free water present in the fibers. Then the dried fibers were subsequently cut into smaller lengths. The Jute fiber based epoxy composite is fabricated using hand lay-up process after proper mixing of the fly ash. The moulds have been prepared with dimensions of 300 × 300 mm. A sliding roller has been used to remove the trapped air from the uncured composite and mould has been closed at temperature 30° C duration 24 hour. The constant load of 50 kg is applied on the mould in which the mixture of the jute, fly ash, epoxy resin and hardener has been poured. After curing, the

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specimen has been taken out from the mould. The composite material has been cut in suitable dimensions with help of zig saw for mechanical tests as per the ASTM standards.

IV. TESTING OF MECHANICAL PROPERTIES

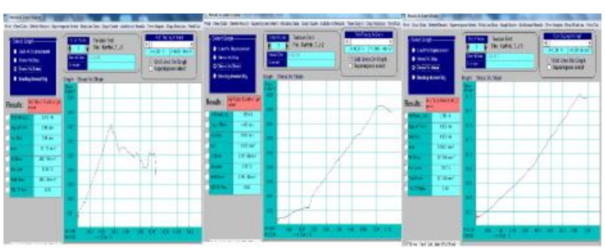
The specimen prepared in three different compositions. Type I specimen having 5 % of fly ash in epoxy matrix, Type II specimen having 10 % of the fly ash in epoxy matrix and the third Type III specimen having 15 % of fly ash in epoxy matrix. Further the fly ash mixing increased and tested, but the resulted mechanical properties found to be worst and in this research it had been limited to three test cases. After the test specimens were cut according to the ASTM standard, various test need to be performed. For identifying the ultimate strength of the developed composite, tensile test had been performed on UTM. For testing the specimen has to follow ASTM D3039 of size 250 mm x 25 mm x 2.5 mm. The gauge length is set to 7 mm.

Test Specimen dimension for flexural test was 100 mm × 15 mm × 70 mm and three point bend test method was used for finding the flexural strength using Universal Testing Machine Instron 1195.

Test Specimen dimension for impact test was 60 mm × 15 mm. Impact testing was conducted in Izod impact testing machine.

V. RESULTS AND DISCUSSIONS

The mechanical properties characterisation test were performed with three different specimen manufactured at different time period and the average of the three test results were assumed to be the result of the test.

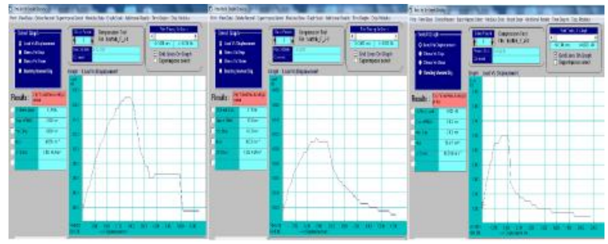


5.1 Tensile Test:

Tensile test is conducted to identify the ultimate strength of the composite and the maximum load carrying capacity. The stress strain plot for jute fiber reinforced 5%, 10%, and 15% fly ash mixed epoxy composite is shown in the Figure 1a, 1b and 1c respectively. The result obtained proved that the ultimate stress value increases as the fly ash content increases in the epoxy. Similarly the load carrying capacity also increases with increase in the fly ash content in the epoxy. Because, the fly ash particles are making a good bonding between the fiber and the epoxy.

5.2 Flexural Test:

The flexural test also performed on the specimen and the load versus displacement curve had plotted and is shown in



the figure 2a, 2b and 2c for 5%,10%, and 15% fly ash mixing with epoxy respectively.

Impact Test:

Impact test had been performed with and without notches on the machine and the results obtained for 5%, 10%, and 15% fly ash mixing with epoxy is given in the Table 1.

Table 1: Impact test result

Sample	Joules
Jute + 5% fly ash	0.2
Jute + 10% fly ash	0.1
Jute + 15% fly ash	0.2

5.4 SEM ANALYSIS RESULTS:

Finally, in order to validate the results and to verify the proper mixing of epoxy and fly ash with the jute reinforcement, SME images were also considered in this research. the obtained images clearly shown the proper reinforcement of the fiber and the correct mixing of fly ash with the epoxy. The SEM image obtained for 5% 10%, and 15% fly ash composites are shown in the Figure 3a, 3b and 3c respectively.

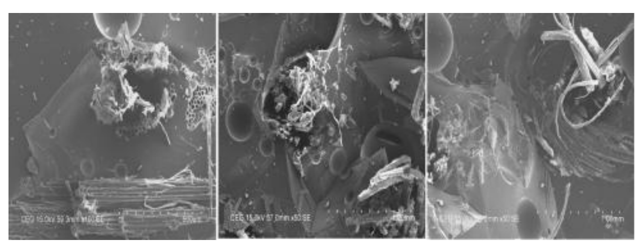


Figure 3: SEM image of jute with 5% 10%, and 15% ash content

VI. CONCLUSION

This experimental examination of mechanical behaviour of jute fiber based epoxy composites indicates that different fly ash percentages on jute fibers has major effect on the mechanical properties of the composites like as hardness, tensile strength, flexural strength and impact strength i.e. the strength increases with increase in the fly ash content and beyond 15% mixing the strength starts decreasing. So the higher mechanical properties are obtained at the 15% fly ash mixing. The elongation and the displacement also reduced for the 15% fly ash mixing compared to the 10% fly ash mixing. It also have been found that the fiber length plays a major role and it has been observed that the better mechanical properties found for composites reinforced with 30 mm fiber length with 15% fly ash. The fabrication of jute fiber based epoxy composites with different fly ash percentages are possible by hand lay-up process.

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