Experimental Investigation of Mechanical Behaviour of Natural Fibre Composite

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Abstract- *This project deals with the EXPERIMENTAL INVESTIGATION ON MECHANICAL BEHAVIOUR OF NATURAL FIBER COMPOSITE. Polymers and their composites are one of the most advanced and adaptable engineering materials. The strength of any composite depends upon number of factors such as volume/weight fraction of reinforcement, types of fibers, orientation angles, chemical treatment of reinforcement, and many others.*

The present work focuses on the analysis of mechanical properties (tensile and flexural) of natural fiber (Hair, Coconut coir & Egg Shell fiber)-reinforced with epoxy composites. An attempt is made to reduce the usage of synthetic glass fibers by natural fibers such that the resultant composite shows increased strength when compared with natural fibers (Hair, Coconut coir & Egg Shell). The test specimens were prepared and tested according to ASTM standards. Experimental results revealed the reinforcement of natural fibers up to some extent increases the mechanical properties and reduces the overall cost of fabrication of composites.

I. INTRODUCTION

Natural fiber reinforced composite materials are considered as one of the new class of engineering materials. Interest in this area is rapidly growing both in terms of their industrial applications and fundamental research as they are renewable, cheap, completely or partially recyclable, and biodegradable. Among all the natural fiber reinforcing materials, jute appears to be a promising material because it is relatively inexpensive and commercially available in the required form

Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications .Research on plastics and cement reinforced with natural fibers such as jute, sisal, coir, pineapple leaf, banana, sun hemp, straw, broom, and wood fibers are done. Although natural fibers reinforced in the polymer matrix are environment friendly, they suffer from lower modulus, lower strength, and relatively low moisture resistance compared to synthetic fiber reinforced composites such as glass fiber reinforced composites. Hybridization of natural fiber with stronger and more corrosion resistant synthetic fibers such as glass fibers and carbon fibers improves stiffness, strength as well as the moisture resistant behavior of the composite While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry. It is obvious, especially for composites, that the improvement in manufacturing technology alone is not enough to overcome the cost hurdle.

It is essential that there be an integrated effort in materials process. Natural fibers are fibers that are produced by plants, animals, and geological processes. They can be used as a component of composite materials, where the orientation of fibers impacts the properties. Natural fibers can also be matted into sheets to make paper or felt.

The earliest evidence of humans using fibers is the discovery of wool and dyed flax fibers found in a prehistoric cave in the Republic of Georgia that date back to 36,000 BP. Natural fibers can be used for high-tech applications, such as composite parts for automobiles. Compared to composites reinforced with glass fibers, composites with natural fibers have advantages such as lower density, better thermal insulation, and reduced skin irritation. Further, unlike glass fibers, natural fibers can be broken down by bacteria once they are no longer in use.

Natural fibers are good sweat absorbents and can be found in a variety of textures. Cotton fibers made from the cotton plant, for example, produce fabrics that are light in weight, soft in texture, and which can be made in various sizes and colors. Clothes made of natural fibers such as cotton are often preferred over clothing made of synthetic fibers by people living in hot and humid climates.

1.1 NATURAL FIBERS:

Recently, the natural fibers are gaining interest as reinforcement in polymer composites rapidly. The natural fiber used as reinforcement from very old time as man used grass and straw from beginning of civilization in reinforcing the bricks that are used to make mud wall. There are many advantages of natural fiber over traditional reinforcing material as such as low density, low cost, enhanced energy recovery, good thermal properties, acceptable specific strength and biodegradable. These fibers are easily and abundantly available, biodegradable and these advantages make natural fiber popular over synthetic fiber such as glass fiber, carbon and other man-made fibers. Natural fibers are naturally occurring materials consisting of cellulose fibrils embedded in lignin matrix. On the basis of the source of origin, natural fibers are characterized into three classifications ,

THEY ARE:

- Mineral Fibers
- Animal Fibers
- Plant Fibers

1.1.1 MINERAL FIBER :

Mineral fibers are the commonly happening fiber or marginally adjusted fibers acquire from minerals. It has different classifications they are taking after: Asbestos is the main commonly happening mineral fiber. The Variations in mineral fiber are the anthophyllite, amphiboles and serpentine. The Ceramic fibers are aluminum oxide, glass fibers, boron carbide and silicon carbide. Metal fibers incorporate aluminium fibers.

1.1.2 ANIMAL FIBER:

Animal fiber for the most part comprises of proteins; illustrations mohair, fleece, silk, alpaca. Animal hairs are the fibers got from animals e.g. horse hair, Sheep's fleece, goat hair, alpaca hair, and so on. Silk fiber is the fibers gathered from dried spit of creepy crawlies throughout the time of readiness of covers. Avian fibers are the fibers from flying creatures. Illustrations silk from silk worms.

1.1.3 PLANT FIBER:

Plant fibers are for the most part comprises of cellulose: illustrations cotton, flax, jute, ramie, sisal and hemp. Cellulose fibers are utilized as a part of the manufacture of paper and material. The classification of these fibers is as taking after: Seed fibers are the fibers acquire from the seed case and seed e.g. cotton. Leaf fibers are the fibers get from the leaves e.g. sisal. Skin fibers are the fibers are get from the skin or bast encompassing the stem of the plant. This fibers having higher elasticity than different fibers.

Accordingly, these fibers are utilized as a part of solid yarn, fabric, bundling, and paper. Tree grown foods fibers are the fibers are get from the products of the soil of the plant, e.g. coconut (coir) fiber. Stalk fiber are the fibers that are acquire from the stalks of the plant. Characteristic fiber composites are not new to humanity. Now-a-days, the natural fiber reinforced polymer composites applications are generally found in automobile industries and building industry and the place where the dimensional stability and load carrying strength under moist and thermal stability conditions is important.

For example, flax fiber based polyolefin are widely used in automotive industry. Here, the fiber acts as a reinforcement in non structural interior. Natural fiber reinforced polymer composites used for structural applications, but then usually with synthetic thermoset matrix material which limit the environmental benefits. The natural fiber composites are very cost effective material for given applications:

For the Furniture: shower, chair, table, etc.

• For the Electrical devices: electricity appliances etc.
• For the daily use: suitcases, lampshades, etc.
• For the transportation: automobile industries and railway coaches, boat etc.

Reinforcement in polymer is either synthetic or natural. Synthetic fibers, for example, glass, carbon are used for polymer composites however their fields of applications are restricted because of high cost. Natural fibers have many advantages over synthetic fibers.

The potential utilization of different natural fibers for polymer composites has already been explored. Among various natural fibers, human hair has many advantages. Human hair has solid malleable property; thus it could be utilized as a fiber reinforcement material. It gives great property at easier expense of generation.

It additionally makes ecological issue for its deteriorations because of its non-degradable properties. To this end, an attempt has been made to study the potential utilization of human hair which is economically and effortlessly found in India for making value added products.

The objective of present work is to evaluate the mechanical properties of human hair reinforced epoxy composites.

The impact of fiber loading and length on mechanical properties like tensile strength, flexural strength, impact strength and hardness of composites is examined.

1.2 PROPERTIES OF HAIR:

Hairs are a potentially ubiquitous trace material in several categories of forensic investigation. Hair is a protein filament which grows from follicles and further found in the dermis or skin.

Hair is one of the defining features of the mammals. The human body apart from zones of glabrous skin is covered in follicles which produces thick terminal and fine vellus hair.The part beneath the skin is called as the hair follicle or when the same pulled from the skin considered as bulb. The length of hair extends from its root or bulb embedded in the follicle which continues into a shaft of the hair and terminates at a tip. The shaft of the hair is composed of three layers i.e., Cuticle, Cortex and Medulla. Cuticle is considered as the outermost layer of the hair, medulla is known as the innermost layer and cortex is considered as middle layer i.e. in between the cuticle and medulla.

Hair is commonly encountered evidence on a crime scene which includes Murder, Homicidal, Sexual assault, accident or many more cases. Different states have different morphological features in hair depending upon their habitat, environment and their eating habits which can resulted into change in their scaling pattern, medulla, cuticle thickness etc. so the hair can be very useful evidence for forensic consideration and interpretation. Several researcher have contributed in this area of work.

A review of previous research work done by different authors is compiled to get an idea about the study conducted in this field and to access the scope of future researches in this field.

1.3 COCONUT COIR:

Coir is a versatile natural fiber, extracted from mesocarp tissue, or husk of the coconut coir fruit. Generally, fiber is of golden color when cleaned after removing from coconut husk; and hence the name, ”The Golden Fiber”.

Coir is the fibrous husk of the coconut shell. Being tough and naturally resistant to seawater, the coir protects the fruit enough to survive months floating on ocean currents to be washed up on a sandy shore where it may sprout and grow into a tree, if it has enough fresh water, because all the other nutrients it needs have been carried along with the seed. Compared to other typical natural fibers, coconut fiber has higher lignin and lower cellulose and hemicellulose, together with its high microfibrillar angle, offers various valuable properties, such as resilience, strength, and damping, wear, resistance to weathering, and high elongation at break.

Coconut fibres have the highest toughness amongst natural fibres.

These characteristics make the fibers quite useful in floor and outdoor mats, aquarium filters and rope.

1.4 EGG SHELL:

EGG SHELL strength has been measured by compression, impact and puncture, but only compression lends itself to the development of a non-destructive measurement of shell strength. If a linear relationship exists between compression force and the induced deformation of the shell, and if the slope of this line is related to force applied at failure of the shell, then a non-destructive test could be developed. The deformation under non-destructive forces would be used to predict the force at failure.

Eggshell contains of 1% magnesium carbonate, 1% calcium phosphate, 4% organic matter, and 94% calcium

carbonate . Based on previous work, it was found that the thickness of its outer and inner eggshell is 0.55 and 0.015 mm Epoxy resin is the word derived from chemical origin. Epoxy resins have less molecular weight.

The color of epoxy resin is brown (or) amber color[1]. These are having high mechanical properties and also increased by high level ofelectrical insulation and good chemical resistance.

Epoxy resins are also having performance properties like biocompatibility, environment friendly and flame resistant [2,3]. Epoxy resins are adhesive and dry in any temperaturefrom 41 to 302 degrees Fahrenheit .they also shrink during curing process. This is used to prevent from internal stresses and also prevents from chemicals. It is cheaper and faster than welding.

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1.5 PROPERTIES OF EPOXY:

Epoxy resins are characterised by their very good electrical properties and chemical resistance, good strength and low absorption of moisture.

They are versatile resins, offering particularly excellent resistance to corrosion (solvents, alkalis and some acids), high strength/weight ratio, dimensional stability and adhesion properties. They are linear polymers produced by condensing epichlorhydrin with bisphenol A. Other formulations are glycidyl esters (for vacuum impregnation, lamination and casting), glycidyl ethers of novolac resins, and brominated resins. They differ from polyesters and vinyl esters in that they do not contain any volatile monomer component. Different resins are produced by varying the ratios of the components.

The resins are relatively high in viscosity, so that they are usually moulded at temperatures in the region of 50-100°C, or dissolved in an inert solvent to reduce viscosity to a point at which lamination at room temperature becomes possible. Curing agents, also referred to as catalysts, hardeners or accelerators, are used, acting either by catalytic action or directly reacting with the resin.With correct additives, epoxy resins can exhibit outstanding resistance to heat (some up too 290°C) and electrical insulation properties. They can be either liquid or solid form and can be formulated to cure either at room temperature of with the aid of heat.

Heat curing is more common for situations where maximum peformance is required. Epoxies generallly cure more slowly than other thermset resins. Cold-cure types are available, but performance is usually better when curing at 40-60°C. Epoxies are frequently used in aerospace and defence, chemical plant and high performance automotive applications.

MIXING RATIO OF COMPOSITE FIBER:

Natural Fibers	Percentage Of NaturalFibers	Percentag of Epoxy
Human HAIR	20%	50%
EGG SHELL	10%	
Coconut coir	20%	

EXPERIMENTAL PART

Mixed materials are (not dry or wet stage) in between the solidification. Before pouring the materials, apply the wax in all the areas, due to good surface finish. Next, pour the already prepared the mixed material in to the core.

At the time of bonding, the material and resins bond with each other and remove the blow holes for uniform flow ability. Improve the stiffness, and strength of the composite beam. After the bonding, 3 to 4 hours is maintained in the atmosphere (air), till the cooling is done completely. Again the composites were put in the same process for next fibre.

Apply the force to gradually compress the die. In this condition, the load is maintained up to 8 hours. (Normally) After 8 hours is completed, the composites are ready.

II. MECHANICAL TEST

SPECIMEN DIMENSIONS:

Specimen prepared by hand lay-up process is cut into required dimensions. The Tensile, Flexural and Impact test specimens are obtained according to ASTM standards. Tensile Test Specimen is prepared into Dog Bone shape of dimensions 165x19x7 mm according to ASTM D638 standard. Flexural Test Specimen is prepared into the Flat shape of dimensions 80x15x7 mm3 according to ASTM D790 standard.

TENSILE TEST:

According to ASTM D-638 standard the tension test can be performed. This test is done by universal testing machine type (LARYEE) with cross-head speed. The mechanical properties of composite are depending on numerous variables like fiber loading and fiber length. According to ASTM D3039-76 test models, the tensile test of composites is carried out utilizing Universal Testing Machine Instron 1195. A load was connected to the both sides of composite samples for the testing. The experimental set up and specimen for tensile test is shown in Figure respectively.

FLEXURAL STRENGTH:

The flexural test of composites is also carried out utilizing Universal Testing Machine Instron 1195. The findings of flexural strength should be the critical characterization of a composites material. For the testing, the cross head rate is kept as 2 mm per min and a span of 60 mm is kept up. The loading arrangement for flexural test is presented in Figure 3.5. The impact tests are carried out as per ASTM D 256 using an impact tester. The experimental set up for impact test.

III. CONCLUSION

By the Tensile, flexural and hardness strength study, it was found that the stiffness can be increased with only 5% of egg shell filler and further increase in the filler quantity reduces the stiffness as the fiber and matrix bonding area reduces. Hardness reduces with the addition of egg shell filler material. By using egg shell filler material the composite doors can be made stiffer and less economical. In future wear test has to be conducted on the same composition samples, studies can be made by using different composition to increase the hardness.

FUTURE SCOPE IN HUMAN HAIR FIBER BASED COMPOSITES

The utilization of waste human hair as a fiber reinforcement in composites enlarges the entryway for further research in the given field. The research can be further extended to study the influence of hair fiber on other properties of composites such physical, thermal and tribological properties.

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