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Hybridization of Composites using Natural and Synthetic Fibers for Automotive Application

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ABSTRACT

The work is centred on the idea of hybridization polymer matrix composites with synthetic and natural fibers. Composite material shows a major part in the pitch of automotive and aircraft industries due of its higher strength and lower weight ratios. The merger of natural fibers like coconut coir with glass fiber composites has enlarged growing claims both in many extents of engineering and technology. The laminate is fabricated by with glass fiber and coconut coir fiber to check their mechanical properties under dissimilar circumstances. The mechanical properties are evaluated by tensile test, hardness test, impact test and their outcomes are measured on segments of the material and make habit of the natural fiber composite material for automotive and aerospace engineering. The macroscopic analyses are conceded out to study the interfacial features of the laminate.
Keywords: Material, Fiber, Composites, Coir, Hybrid

I. INTRODUCTION

Composites remain multifunctional solid systems that offer characteristics not attainable from any distinct material. They are unified structures finished by physically merging two or more well-suited materials, dissimilar in structure and features and occasionally in form. Metal Matrix Composites have several benefits over monolithic metals like complex specific modulus, greater specific strength, improved possessions at elevated temperatures, and lesser coefficient of thermal expansion [1-3]. The foremost objective in making ceramic matrix composites is to raise the toughness. Certainly it is expected and undeniably frequently noticed that there is a parallel enhancement in strength and stiffness.

Utmost frequently utilized matrix materials are polymeric. The motives for this are dual. In overall the mechanical possessions of polymers are insufficient for several structural tenacities. In specific their strength and stiffness are lesser equated to metals and ceramics. These hitches are stunned by strengthening other materials with polymers. Then the treating of polymer matrix composites must not comprise higher pressure and doesn't necessitate higher temperature [4]. Also equipment requisite for developing polymer matrix composites are meeker. For this purpose polymer matrix composites established quickly and soon became prevalent for structural uses. Composites are utilized since whole properties of the composites are greater to those of the separable components for instance polymer/ceramic. Composites have a better modulus than the polymer constituent but not as brittle as ceramics.

A. Fiber Reinforced Polymer

Fibers are the bolstering and the key basis of strength while matrix fastens all the fibers composed in shape and transmits stresses among the reinforcing fibers. The fibers transport the loads in the longitudinal ways. At times, filler might be supplementary to even the making process, influence special things to the composites, and lessen the product price. Common fiber strengthening agents comprise carbon fibers, asbestos, graphite fibers, beryllium carbide, molybdenum, beryllium oxide, aluminium oxide, polyamide glass/natural fibers etc. Likewise common matrix materials contain phenolic epoxy, vinyl ester, polyurethane polyester, polyetherethrketone, etc. Amongst these resin materials, polyetherethrketone is extensively used. Epoxy, which has greater bond and lesser contraction than polyetherethrketone, derives in second for its higher price [5].

B. Particle Reinforced Polymer

Particles utilized for strengthening contain ceramics and glasses like smaller mineral/ metal particles like aluminium and amorphous materials, containing polymers and carbon black. Particles are utilized to raise the units of the matrix and to decline the ductility of the matrix. Particles remain utilized to lessen the price of the composites. Reinforcements and matrices could be collective economical materials and are simply managed [6]. Several valuable properties of ceramics and glasses embrace higher melting temperature, lower density, and higher strength; wear resistance, stiffness and corrosion resistance.

Benefits of composites above their straight complements are the capability to meet dissimilar design necessities with substantial weight reserves. Some benefits of composite materials above straight ones are as:

- Tensile strength of is 4 to 6 times superior to steel/aluminium.
- Enhanced torsional stiffness and influenced properties. Developed fatigue endurance range (60% of tensile strength)
- 30% to 40% light in weight for structures to the same functional requirements.
- Inferior embedded energy equated to added structural metallic supplies like aluminium, steel, etc.
- Low noise during process and deliver lesser vibration than metals.
- Highly flexible than metals and could be handmade to chance the needs and difficult design necessities.
- Longer life compromise admirable impact, fatigue, and environment resistance and lesser maintenance.
- Condensed life cycle rate equated to metals. Composites display admirable fire retardancy and corrosion resistance.
- Enriched appearance with even surfaces and readily incorporable integral decorative melamine are added characteristics of composites.

II. LITERATURE SURVEY

The development of natural fibre reinforced composite-based products to substitute traditional engineering materials is becoming a trend in engineering application. Despite the inherent advantages of lower price, less density, inexpensive precise mechanical properties and sustainability, these agricultural wastes seem to have some limitations of susceptibility to microbial and environmental challenges that preclude their use for product standardization and repeatability. In this study, composite panels made by hand lay-up technique from randomly oriented bamboo fibres reinforced polyester matrix were evaluated. The processing parameters included surface treatment of fibers in phenyls lane, manipulation of fiber content and evaluation of ash content in relation to the mechanical properties [7]. The outcomes display that the tensile/flexural/Izod impact strength, including modulus of elasticity and rigidity values for the samples were similar to those of kenaf and talc fiber composites.

The scanning electron microscopy and energy dispersive spectroscopy analysis of the samples suggest that the composition of higher ash content in the treated bamboo fibre reinforced polyester composite panels, coupled with the non-significant effect of surface treatment, is indicative of correlation between ash content and mechanical possessions of bamboo fibre strengthened polyester composites. It is inferred from the results that surface treatment processes may not necessarily be required for bamboo fibre as reinforcement in composites production for some low-to- medium structural applications. In terms of real concern, the bamboo fibre composites can be considered as usable replacements to substitute certain straight fibres as reinforcement in polyester matrix in areas of low strength structural applications. In spite of the fairly lesser strength exhibition of bamboo fibre composites, they are stronger than kenaf and talc composites and can be considered for the production of low strength building products such as panels and ceilings. The fact that these natural fibre composites are impervious to moisture and still support deformation, represent advantages in contrast with the moderately brittle gypsum board, which weakens in exchange with water.

Generally, the strength of fibre reinforced composite structures depends mainly on the morphology, volume, planning and kind of fibre in the resin matrix. By changing these parameters, the strength properties can be tailored to meet specific demands. Also noted is the stiffness and strength-to- weight properties that make some composite materials like carbon fibre composites attractive for applications in aerospace and sporting goods, including the extensive application of glass fibre composites in the chemical industries and marine and automobile applications, need be challenged with the development of comparable strong products from bamboo fibre composites in less structural product applications [8].

The material cost savings arising from the use of relatively low cost bamboo fibre, low density, renewability, biodegradability, higher filling levels subsequent in higher stiffness properties, higher specific properties are some of the benefits of use of bamboo fibre-based materials. Also, the non-food farm-based economy, lesser energy ingesting is utmost of the issues that cannot be easily ignored in the engineering study and progress in the extent of Bamboo Fibre Reinforced Polyester Composites (BFRPC). The development of composite products from bamboo fibre materials will address the many needs of alternative to glass fibre for use in low cost housing and low strength structural applications, including the creation of job and wealth from waste while protecting our environment from pollution problems [9].

In most of the cases fracture in polymer-matrix composites usually begins with cracking of the fibre component of the composite. The manner in which this initial fracture progresses determines the toughness of the composite. When a fracture occurs in an isolated fibre at any point along its length, the stresses carried by the fibre in the vicinity of the crack must be transferred to the surrounding matrix and other fibres, so much so that, if the surrounding matrix and fibres are able to withstand the stresses, the fracture will stabilize at that location, but will begin at other locations if the deformation is continued [10]. This process will continue until the damage is so widely spread that the stress originally carried by the fractured fibres can no longer be carried by the un-cracked matrix, at which point ultimate fracture of the composite occurs.

III. METHODS AND MATERIAL

A. Materials used

Matrix epoxy, polyvinyl ester polyester, phenolic resin, polyurethane resin, unsaturated polyester, reinforcement glass fiber, aramid fiber, carbon fiber, natural plant fibers (nettle, sisal, banana, flax, hemp.) All these fibers are in the arrangement of unidirectional mat, bidirectional (knitted) mat, sewed into a fabric form, mat of randomly oriented fibers.

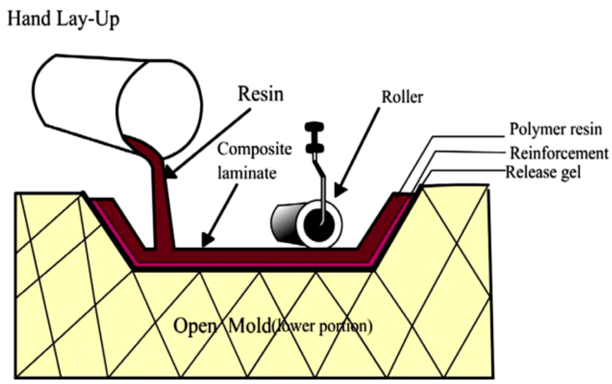

Fig.1 Hand Lay-up Method


Fig.2 Laminated Coconut Coir

B. Method of Lamination

- The lamination of coconut coir and E-glass fiber is done by using hand lay-up method. In the first step the wax is applied over a mica sheet so that the laminate can be easily separated.
- In the next step, the E-glass fiber sheet is placed over the wax coated mica sheet. Then the epoxy resin is mixed with the hardener in the suitable proportions.
- Then the mixture of hardener and epoxy resin were applied over the glass fiber which retained over the

mica sheet. The epoxy resin mixture is placed fully above the glass fiber.

- The coconut coir is taken and it is placed over the resin mixture as a second layer to glass fiber. The coconut coir will act as a natural fiber and it is spreaded over the epoxy resin and hardener mixture.
- Once again the epoxy resin and hardener blend is completely applied fully over the coconut coir layer, so that it can form another layer over E- glass fiber.
- In the next step a fresh layer of E-glass fiber is placed over and it is rolled over tightly to fix firm together. Once again the epoxy resin mixture is applied and followed by the coconut coir layer.
- Finally another layer of E- glass fiber is placed over the laminate and it is wrapped up. Thus the laminate is fabricated and it has been placed under weight for a week, so that it can be tightened together to form a laminate.

IV. RESULTS AND DISCUSSIONS

A. Tensile Test: The Ultimate Tensile Strength for the samples of the composites. According to the graph we can easily found the strength of the samples and also find the Ultimate Tensile Strength of the composite materials.

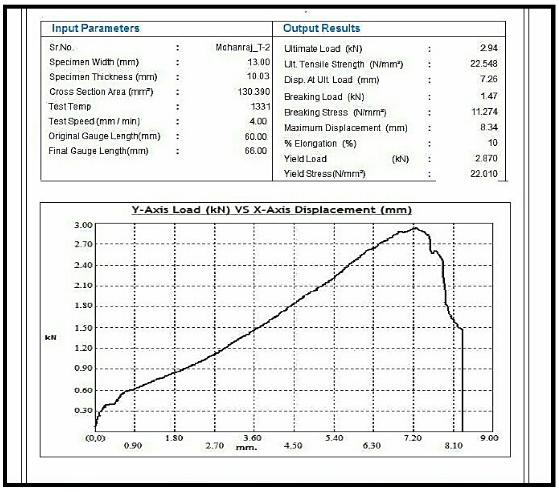

Fig.3 Tensile Test

B. Impact Test (Charpy):

Width of the specimen = 10mm
Breadth of the specimen = 8.5mm
Length of the specimen = 55mm

TABLE I CHARPY IMPACT TEST

Samples	S1	S2	S3
Impact Strength in Joules	2	4	3

From the table we can easily compare and find the best sample and also find the impact (charpy) strength of the composites based on their orientations.

C. Impact Test (Izod)

Width of the specimen = 10mm
Breadth of the specimen = 8.5mm
Length of the specimen = 75mm

TABLE II IZOD IMPACT TEST

Samples	S1	S2	S3
Impact Strength in Joules	4	4	3

From the table we can easily compare and find the best sample and also find the impact (izod) strength of the composites based on their orientations.

D. Rockwell Hardness Test: Ball used = 1/16" mm

TABLE III ROCKWELL HARDNESS TEST

	Load = 600 N		
Samples	S1	S2	S3
Hardness In RHN	62	60	67

The above table indicate the hardness capacity of the composite materials by using the Rockwell Hardness Number (RHN). From the above table shows that the sample 3 has a highest hardness number is 67.

E. Brinell Hardness Test: Ball used = 5mm.

TABLE IV BRINELL HARDNESS TEST

	Load = 1875 N		
Samples	S1	S2	S3
Hardness in BHN	38.92	42.57	35.65

The above table indicate the hardness capacity of the composite materials by using the Brinell Hardness Number (BHN). From the above table shows that the sample has a highest hardness number is 42.57 BHN.

F. *Flexural Test:*

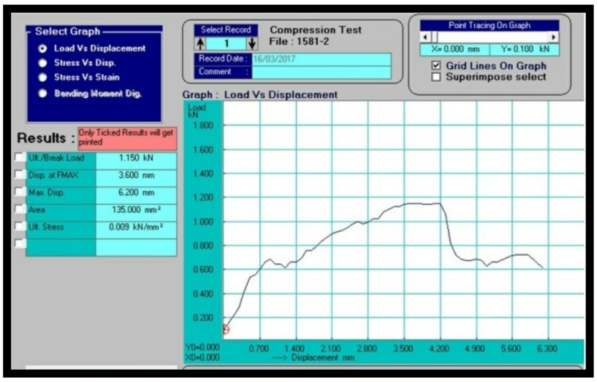

Fig.4 Flexural Test

TABLE V OVERALL VALUES OF MECHANICAL TESTING

TESTING	RESULTS
Tensile strength test	3.77KN
Flectural test	1.15KN
Impact test (charpy)	4 Joules
Impact test (Izod)	4 Joules
Rockwell hardness test	67 HRC
Brinell hardness test	42.57 BHN

The test for mechanical properties of the composites shows composites has significant properties such as tensile Strength, flexural test, hardness and Impact strength. So that the composite material having high tensile strength, flexural, impact and hardness strength higher than mechanical properties wooden particles. Then the material can be easily modified for furniture applications

V. CONCLUSION

The composite of coconut coir, E-glass fiber, and reinforcement epoxy were made in order to evaluate mechanical properties were studied. The tests for mechanical properties such as tensile, hardness, flexural and impact test. Then natural and synthetic fibers are easily converting a composite material were made. This project shows that successful fabrication of a natural fiber with synthetic fiber and reinforced epoxy composites by hand layup technique. The resulted value shows of Tensile strength and Flexural test are 3.77KN and 1.15KN. The Impact strength is 4Joules whereas the Hardness of Brinell and Rockwell were 42.57BHN and 67HRC. Then the material can be used for the furniture, hulls, automobile and aerospace applications.

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