EVALUATION OF FLEXURAL STRENGTH OF COIR FIBER REINFORCED POLYMER MATRIX COMPOSITES

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ABSTRACT

The main objective of this project work is to develop a new composite material using natural fibers. For our project we interested to take COIR fibers as reinforcement and VINYL ESTER resin as matrix. COIR fiber being economical compared to Glass fiber, which giving nearly same strength, VINYL ESTER being less viscous allows good wetting and good adhesion to fibers which helps in laminate preparation without misalignment of fibers. Simple hand layup technique is used for the preparation of laminates. The prepared composites of different ratios is been cut into ASTM standard. Finally the Mechanical test conducted to determine the FLEXURAL strength. The tests will be carried out in Universal testing machine and dry abrasion tester TR-50, and test will be performed as per their respective ASTM standard test procedure.

Keywords: Coir Fiber, Vinyl Ester, Flexural Strength, Natural Composites

I. INTRODUCTION

Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. Historical examples of composites are abundant in the literature. Significant examples include the use of reinforcing mud walls in houses with bamboo shoots, glued laminated wood by Egyptians (1500 BC), and laminated metals in forging swords (1800 AD) Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications. 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 design, material, process, tooling, quality assurance, manufacturing, and even program management for composites to become competitive with metals.

The composites industry has begun to recognize that the commercial applications of composites promise to offer much larger business opportunities than the aerospace sector due to the sheer size of transportation industry. Thus the shift of composite applications from aircraft to other commercial uses has become prominent in recent years. Increasingly enabled by the introduction of newer polymer resin matrix materials and high performance reinforcement fibers of glass, carbon and aramid, the penetration of these advanced materials has witnessed a steady expansion in uses and volume. The increased volume has resulted in an expected reduction in costs. High performance FRP can now be found in such diverse applications as composite armoring designed to resist explosive impacts, fuel cylinders for natural gas vehicles, windmill blades, industrial drive shafts, support beams of highway bridges and even paper making rollers. The constantly increasing demand for materials that have a high degree of structural stability with a high degree of strength, has focused attention on development of natural fibers reinforced polymer matrix composites, which has many technological advantages such as low weight, high specific strength and stiffness, environmental resistance and long life compared metals.

II. LITERATURE SURVEY

As a result of the increasing demand for environmentally friendly materials and the desire to reduce the cost of traditional fibers (i.e., carbon, glass and aramid) reinforced petroleum-based composites, new bio-based composites have been developed. Researchers have begun to focus attention on natural fiber composites (i.e., biocomposites), which are composed of natural or synthetic resins, reinforced with natural fibers. Natural bers exhibit many advantageous properties, they are a low-density material yielding relatively lightweight composites with high specific properties. These fibers also o.er signi.cant cost advantages and ease of processing along with being a highly renewable resource, in turn reducing the dependency on foreign and domestic petroleum oil. Recent advances in the use of natural fibers (e.g., .ax, cellulose, jute, hemp, straw, switch grass, kenaf, coir and bamboo) in composites have been reviewed by several authors.

Harish et al.developed coir composite and mechanical properties were evaluated Scanning electron micrographs obtained from fracture surfaces were used for a qualitative evaluation of the interfacial properties of coir /epoxy and compared with glass fibers.

Wang and Huang had taken a coir fiber stack, characters of the fibers were analyzed. Length of the fibers was in the range between 8 and 337 mm. The fibers amount with the length range of 15~145 mm was 81.95% of all measured fibers. Weight of fibers with the length range of 35~225 mm accounted for 88.34% of all measurement. The average fineness of the coir fibers was 27.94 tex. Longer fibers usually had higher diameters. Composite boards were fabricated by using a heat press machine with the coir fiber as the reinforcement and the rubber as matrix. Tensile strength of the composites was investigated. Nilza et al. use three Jamaican natural cellulosic fibers for the design and manufacture of composite material. They took bagasse from sugar cane, banana trunk from banana plant and coconut coir from the coconut husk. Samples were subjected to standardized tests such as ash and carbon content, water absorption, moisture content, tensile strength, elemental analysis and chemical analysis.

Bilba et al. examined Four fibers from banana-trees (leaf, trunk) and coconut-tree (husk, fabric) before their incorporation in cementitious matrices, in order to prepare insulating material for construction. Thermal degradation of these fibers was studied between 200 and 700 °C under nitrogen gas flow. Temperature of pyrolysis was the experimental parameter investigated. The solid residues obtained were analyzed by classical elemental analysis, Fourier Transform Infra Red (FTIR) spectroscopy and were observed by Scanning Electron Microscopy (SEM). This study has shown (1) the relation between botanical, chemical composition with both localization of fiber in the tree and type of tree; (2) the rapid and preferential decomposition of banana fibers with increasing temperature of pyrolysis and (3) the rough samples are made of hollow fiber. Conrad [5] investigates the connection between the distribution of lignin and pectin and the loading of Pb and Zn on coir.

III. MANUFACTURING PROCESS

The main objective of this project work is to develop a new composite material using natural fibers. For our project we interested to take long COIR fibers for reinforcement and VINYL ESTER resin for matrix and coconut shell powder as an additive. COIR fiber being economical compared to Glass fiber, which giving nearly same strength, VINYL ESTER being less viscous allows good wetting and good adhesion to fibers which helps in laminate preparation without misalignment of fibers. We have adopted the hand-layup process to fabricate the coir fiber reinforced vinyl ester resin laminates because hand layup process is one of the easiest and economical processing methods. Care has to be taken to maintain precision while placing coir fiber in to the mould and while smearing the vinyl ester and hardener mixture over the reinforcement. A table with smooth surface finish has been taken and is made sure there are no irregularities on the surface.

IV. FIBRICATION PROCESS

Here firstly, we took the half kg of **COIR** fiber upon which 44gm was used for experimental work. The coir is then cleaned in an sodium hydroxide pallets (NAOH).After the removal of dust, dirt on the **COIR** surface, the coir is placed in a sunlight to get dry. The COIR density is been calculated, the density of coir is 0.23gm/cm^3. The long **COIR** fibers is then being cutted into 50mm length. Applying wax and placing Mylar sheet on the mould. Before we start to prepare the laminates, wax polish is applied on mould which serves for 2 purposes. One is for easy removal of finished composite and the other is to fill up the cracks on the board. The wax is applied completely on the lower portion of the mould and a Mylar sheet is cutted according to mould dimension and placed over it. It helps in getting a smooth finish at the bottom face of the prepared composite.

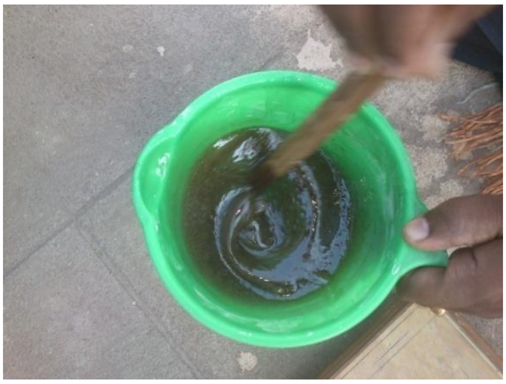

Fig. 1:Adding hardener & catalyst to vinyl ester & Stirring the mixture

For our experimental work we took 5kg of vinyl ester among which 1kg 443gm were used for work. Before pouring vinyl ester into mould a reactive chemicals has to mix to vinyl ester.ie, promoter, hardener & catalyst. Promoter-Is used to promote or to initiate the reaction with vinyl ester. Hardener-Is used to accelerate the reaction. and Catalyst-Is used to balance the reaction. Here for 100gm of vinyl ester 1.5ml of promoter, hardener &catalyst is to be used. So according to different ratios of vinyl ester(100%,95%,90%,85%,80%).The calculated quantity of promoter, hardener & catalyst is used. After the mixing of catalyst into the vinyl ester the reaction gets in a faster rate hence the vinyl ester has to poured into the mould before its get harder. The vinyl ester should uniformly distributed over the mould surface.

Fig. 2: Spreading coir on vinyl ester

The coir which is cutted into 50mm length is spreads on the poured vinyl ester. The COIR has to spreads on vinyl ester before it gets into hard. The fibers is to carefully dip into vinyl ester, so that the fibers will not protrude outside. The coir fibers is to uniformly distributed. The mixture is to dry in sunlight about 5-6 hours, by applying small load on it.

For Five ratios of coir fibers and vinyl ester, the coir quantity are 5%, 10%, 15% & 20%. As per the ratios and quantities mentioned above the coir and vinyl ester is used for the preparation of the laminates. There are 5 laminates of different ratios are prepared.

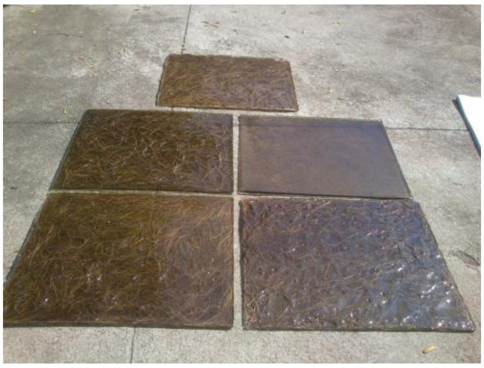

Fig. 3: Prepared laminates

The above prepared laminate is taken for cutting in band saw cutting machine according to ASTM standards. **Flexural** specimen code is **D790** for composite materials and the standards are shown below.

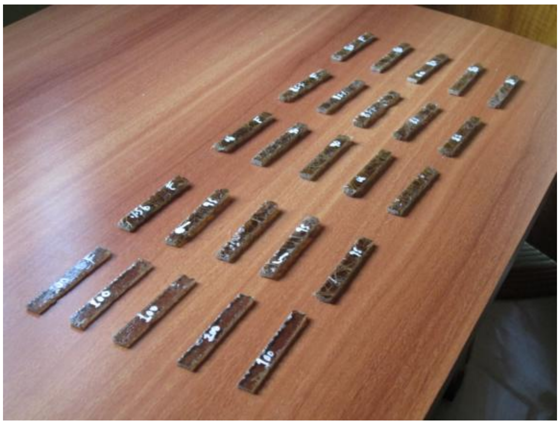

Fig. 4: Specimen according to ASTM standard

V. RESULTS

The results of the 20 specimens subjected to flexural load under various conditions of different ratios along with the graph is as shown below, upon which analysis is made and conclusion can be given.

Specimen Ratio Vinylester:coir %	Load in N	Extension in mm	Three point bend stress N/mm^2
100:0 (4samples)	237.1	13.81	197.58
	95.92	4.552	58.73
	71.31	3.905	59.28
	91.98	4.416	56.32
95:5 (4samples)	78.20	1.249	28.99
	83.79	1.421	39.28
	131.1	1.646	61.43
	105.3	1.9	39.01
90:10 (4samples)	262.0	2.316	78.61
	171.9	2.252	63.67
	146.1	2.075	54.11
	171.9	1.360	51.57
85:15 (4samples)	220	2.909	66.23
	67.38	0.9495	24.96
	102.6	1.287	37.99
	152.2	2.158	56.37
80:20 (4samples)	121.2	1.714	44.88
	209.3	3.062	62.79
	206.7	3.168	76.56
	95.41	1.095	35.34

Table 1: Tabulation of Experimental values

VI. CONCLUSION

The values obtained from the above graphs and result shows that fiber content plays a major role in determining mechanical properties of Natural fiber reinforced polymer resin composite. In natural fiber (coir) reinforced polymer matrix(vinyl ester). It is recommend to use Coir at an moderate ratio and the air bubbles in the laminate should be avoided and the fiber distribution has to be uniform throughout the laminate to get better strength.

In this work we conducted two testes on natural fiber reinforced polymer matrix ie, Coir and vinyl ester composite. Initially for 100:0 ratio of coir and vinyl ester composite shows a more elastic behavior due to zero content of coir, the specimen has only resin. As the coir content increases the stress on composite specimen increases& material carry more load, the 3 point bending stress increases with increase of fiber content. At certain stage due to improper distribution of coir fiber, the composite takes very low load and low bending stress.

VII. BIBLIOGRAPHY

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