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CHARACTERISTICS AND MECHANICAL PROPERTIES OF REINFORCED POLYMER COMPOSITES

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ABSTRACT

In this work, fabrication of coconut fiber (Glass Fiber/Coconut Fiber) in Polyester based composite materials is studied. The fabrication of composite material consist of different fibers reinforced with base material is investigated and characterized the mechanical properties of the fabricated composite material. In this work the composite consisting of a polyester resin matrix reinforced with different fiber orientation are used due to their high strength, light weight and free from corrosion. In this study, composite materials are fabricated into sheets of two different composites by hand-layup method and these are portioned into specimens. These specimens are tested by various tests and their micro structure is examined. By addition of coconut fiber (Glass Fiber/Coconut Fiber) in Polyester based composite materials has not shown any significant improvement in mechanical properties such as Tensile and Hardness results, but it showed comprehensive improved impact strength.

Keywords: coconut fiber, polyster, polyvinyl alcohol, mechanical properties, coir.

1. INTRODUCTION

The most prevalent superior composites materials are polymer matrix composites. The composites were consisting with reinforcement of fibers like polymer thermosetting or thermoplastic and these can be made into a various shapes and sizes for the requirement. It poses the good mechanical characteristics like high vigor, stiffness, good resistance and good corrosive resistance even though they can make simple manufacturing principles with low cost. Because of these reasons most of the researches were focused in the composite material area.

The natural fiber generally consists of cellulose, lignin, pectin, waxes, hemi-cellulose and dihydrogen monoxide soluble substances. Chemical compositions of the natural fibers were differing from each other with the rising conditions and test methods, still for the same kind of fiber. The cellulose is semi crystalline polysaccharide composed of Dglucopyranose units linked with b-glucosidic bonds. In the natural fibers the hydrophilic properties were lead to moisture absorption, very low resistance and very low interface. The reinforced hydrophobic matrices were used to the substantial amount of hydroxyl group in the cellulose and hemi-cellulose is vigorously bounded to cellulose, it is fibrils presumably by hydrogen bonds.

The hemi-cellulosic polymers are fully amorphous which contain an appreciably lower molecular weight than the cellulose. It is moderately soluble in dihydrogen monoxide and hygroscopic due to its open constitution containing many hydroxyl and acetyl groups. Lignins are extremely intricate, amorphous, mainly aromatic, polymers of phenyl propane units. But it had the least dihydrogen monoxide absorption of the natural fiber components. According to the source of inchoation, natural fibers can be relegated into three ways such that mineral fibers, animal fiber and vegetable fiber. The cellulosic are plays a vital role in the improvement of mechanical behavioural characteristics. In the eco friendly composite are necessary for save the earth especially save the health of the soil.

Table-1. Properties of natural fibers.

Fiber	Tensile strength (MPa)	Young's modulus (GPa)	Elongation at Break (%)	Density (g/cm3)
Bamboo	140-230	11-17	-	0.6-1.1
Banana	500	12	5.9	1.35
Coir	175	4 – 6	30	1.2
Cotton	287-597	5.5 –12.6	7 – 8	1.5 – 1.6
Curaua	500-1150	11.8	3.7 – 4.3	1.4
Date palm	97 – 196	2.5 – 5.4	2 – 4.5	1 – 1.2
Jute	393-773	26.5	1.5-1.8	1.3
Pineapple	400-627	1.44	14.5	0.8-1.6

2. LITERATURE REVIEW

Abilash. N *et al.* 2013 the mounting ecumenical environmental and convivial concern, high rate of decline of petroleum resources, and new environmental policy have forced the look for natural composite materials, adjusted with their environment. The aims is to integrate value to the crops by processing the fibers into soi-disant natural fiber composites. Composites are hybrid materials composed of a polymer resin reinforced with the fibers, coalescing the high mechanical and physical performance of the fibers and the appearance, bonding together and enriching the physical properties of polymers [1]. Beena James *et al.* 1999 the ecumenical demand for wood as a

building material is steadily growing, while the availability of this natural resource is diminishing. This kind of situation has most important to the development of alternative materials. [2]. Bongarde *et al*. 2014 deals with review of different natural fibers reinforced polymer composite with its manufacturing processes and characterization especially coir and jute fiber[3]. Chandramohan, D. *et al.* 2013 discusses micro structure of the specimens are scanned by the Scanning Electron Microscope. The disclosure includes the process to make the composite and additionally the variety of products in automobile adjuncts [4-5]. Deepa B *et al.* 2011 analysed on the recyclability and reprocessing of agro predicated fiber composites and the effect of mechanical and thermal degradation parameters during the recycling processes [6]. Girisha.C *et al.* 2012 studies the dihydrogen monoxide absorption pattern of these composites at room temperature was found to follow Fickian comportment, whereas the dihydrogen monoxide absorption properties at higher temperature did not follow Fick's law [7].

Irene S. Fahim *et al.* 2009 The result of investigating these two mechanical properties, utilizing statistical analysis & design of experiments, showed an enhancement in the mechanical properties of the virgin polymer composite compare to the virgin polymer. The flexural stress of the composite incremented three times the virgin flexural stress, while the tensile stress incremented eight times the pristine tensile stress [8]. Pattarachaiyakoop. N *et al.* 2011 This paper is a review on the tensile properties of natural fiber reinforced polymer composites. In general, the tensile strengths of the natural fiber reinforced polymer composites boost with fiber content, up to a maximum or optimum value, the value will then drop. However, the Young's modulus of the natural fiber reinforced polymer composites increase with incrementing fiber loading [10]. Pathania.D *et al.* 2009 The dielectric constant and dielectric dissipation decremented with frequency and incremented with temperature, where as the dielectric loss factor decremented with the incrementation of frequency at fine-tuned temperature and incremented with temperature at lower frequencies. It is additionally observed that the dielectric loss factor decrease with chemical treatment [11]. Punyapriya Mishra *et al.* 2010 In this paper, an experimental study has been conducted for determining the abrasive wear deportment of bagasse fiber reinforced epoxy composite in different directions, namely anti-parallel orientation (APO) , parallel orientation (PO) and mundane orientation (NO) by utilizing a two body abrasion wear tester[12]. Raghavendra.S *et al.* 2013 composites are made utilizing short Banana fibres and natural rubber. Composites are yare utilizing vulcanizing technique at 1500^0c. And composites obtained were resolute for mechanical properties like tensile vigor, tear vigor were studied. The effect of different lengths of fiber content with natural rubber were resolute .also matrix fiber interface were studied utilizing SEM [13]. Rafia Akter *et al.* 2012 Woven natural fibre reinforced polymer composites consisting of Pati bet withal kenned as murta (Clinogyne dichotoma) reinforcement, unsaturated polyester resin (UPR) matrix and talc filler were fabricated by simple cold press molding. Thermosetting unsaturated polyester resin with 7.5% styrene monomer was utilized as matrix which form gel in 2-3 hours by utilizing 1.5% methyl ethyl ketone peroxide (MEKP) hardener. Double layer woven fibre mats were utilized. Talc was utilized as at different weight percentages (5%, 10% and 15%) to investigate its effects on different properties of composites. It was observed that flexural vigor and modulus incremented with an incrementation in talc content. Thermal stabilities of composites were additionally ameliorated [14].

3. SCOPE OF THE WORK

To this end, the present research work were undertaken to study the processing, characterization of short natural fiber reinforced polyester composites. Endeavors have withal been made to explore the possible utilization of a natural fiber for making value integrated product and the effect of sundry mechanical performance of composite material.

In this present study, it was utilized a thermoset polymer (polyester) as the matrix and woven glass fiber utilized as a reinforcing material and coconut coir utilized as a filler material to prepare a composite material by hand layup technique and the specimen were cut as per ASTM standard and to determine the mechanical properties of the composite according to the reinforcing filler content in deference to unsaturated polyester.

4. FABRICATION OF NATURAL COMPOSITE

The subsequent constituent materials were used for fabricating the plate:

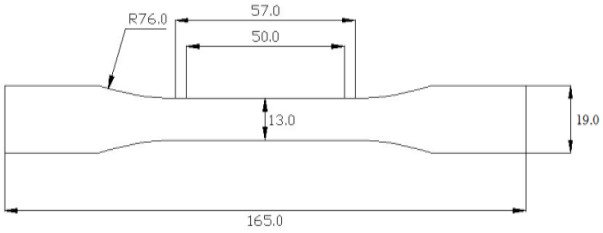
1. E-glass woven roving as reinforcement material
2. Polyester as resin
3. Hardener as catalyst
4. Polyvinyl alcohol or wax as a releasing agent
5. Coconut Fiber used as a filler material

For the production of composite, hand lay-up is an easy method. A mold should be used for hand lay-up parts unless the composite are joined directly to another structure. The mold is made up flat sheet or contain never-ending curves and edges. For some shapes, molds must be joined in sections so it can be taken apart for part removal after curing.

Before starting lay-up process, the mold should be made with a releasing agent to assure that the part will not adhere to the mold. For laiding on the mold, reinforcement fibers are to be cut. It is up to the designer to organize the type, amount and direction of the fibers being used. Resin must then be catalyzed and added to the fibers. A roller, squeegee or brush are to be used to impregnate the fibers with the resin.

a) Specimen for tensile test

As per ASTM (American Standard Testing Methods) the code for tensile test is D638



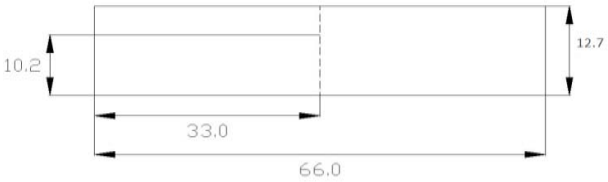
All Dimensions are in 'mm'

Figure-1. ASTM standard for tensile test.

Size of tensile plate (length*breath*thickness) = (165 x 19 x 4) mm.

b) Specimen for impact test

As per ASTM (American Standard Testing Machines) the code for impact test is D256



All Dimensions are in 'mm'

Figure-2. ASTM standard for impact test.

Thickness of the specimen =4mm

5. RESULTS AND DISCUSSION

In this research composite material was yare by hand layup technique. The mechanical properties of Polyester / Glass fiber & Polyester /Glass Fiber/ Coconut Fiber / were studied. Sundry mechanical properties investigations were carried out predicated on the mechanical properties composite material Polyester / Glass fiber & Polyester /Glass Fiber/ Coconut Fiber / had given good mechanical properties. Overall results when we compare the mechanical properties of composite materials we conclude additament of coconut fiber has given very good mechanical vigor. Tensile, Impact and Hardness results were additionally ameliorated by integrating of different fiber (Glass Fiber/Coconut Fiber) in Polyester predicated composite materials.

a) Mechanical test results

a) Tensile Test
b) Impact Test (IZOD)
c) Hardness Test (Rockwell Hardness L Scale)

i. Tensile test for polyester/glass fiber

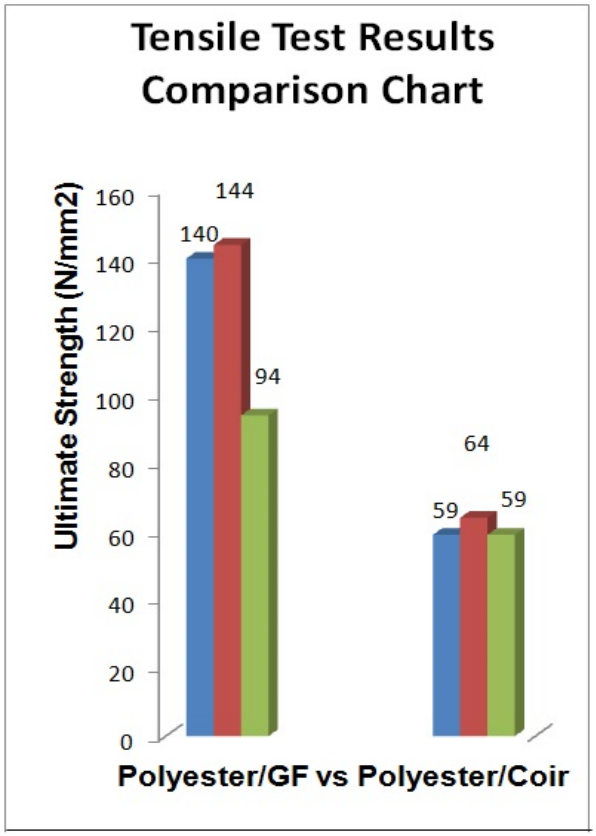
The tension test is usually performed on the level specimens. The specimen geometries of the straight sided specimen and canine-bone specimen with end tabs. A uni-axial load is applied through the cessations. As per the ASTM, D638 for the normal test, it recommends that the specimens with parallel fibers to the loading direction should be 19 mm wide, 165 mm of length and 4 mm of thickness. The canine bone type specimen was used and having dimensions as specified ASTM standards. The tensile test was performed on all the three samples as per ASTM D638 test standards.

ii. Impact test (IZOD) for polyester/ glass fiber

The impact test shows the crack propagation mechanism between the filler material and the matrix polymer, this test affected the crack instigation. Figure-4 illustrates that the impact vigor slumps with incrementing filler loading. This is mainly due to the reduction of elasticity of material due to filler additament and thereby reducing the deformability of matrix. An incrementation in concentration of filler reduces the competency of matrix to absorb energy and thereby reducing the toughness, so impact vigor plummeted.

iii. Rockwell hardness l scale test for polyester/glass fiber

Hardness test (L-Scale)
Major Load: 60 Kg
Minor Load: 10 Kg
Indenter: ¼" Ball



Figur-3. Tensile test results comparison chart.

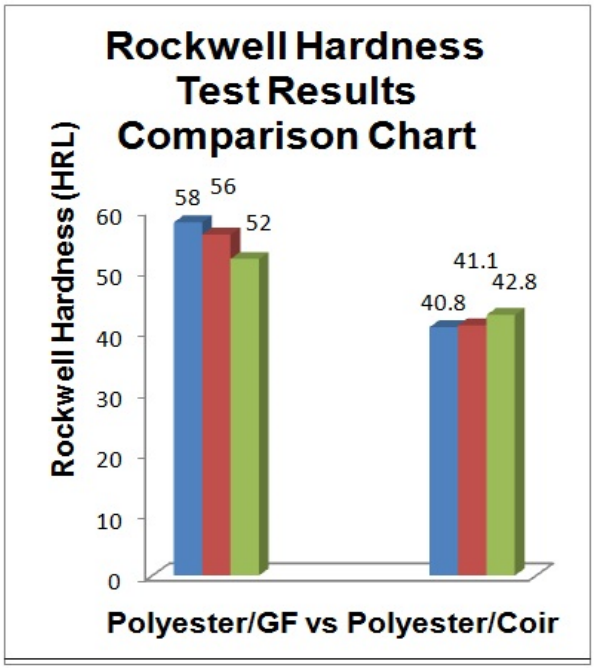


Figure-4. Rockwell hardness test results comparison chart.

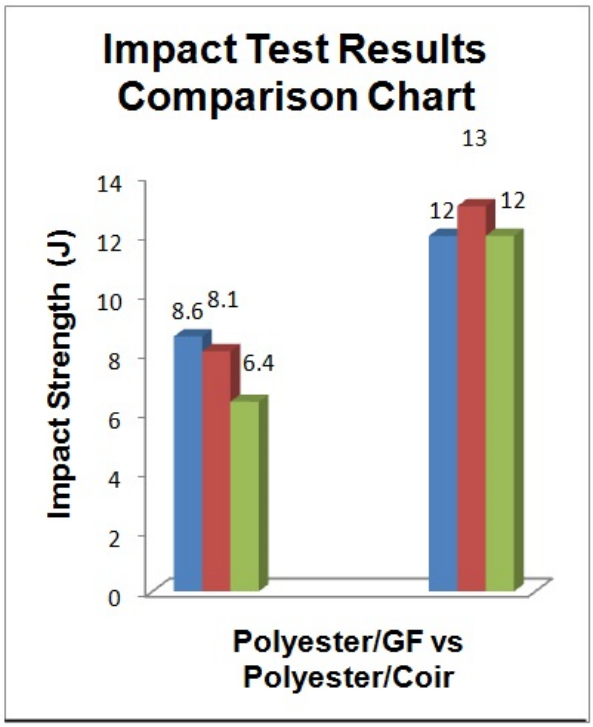


Figure-5. Impact test results comparison chart.

In this research composite material was made by hand layup technique. The mechanical properties of Polyester / Glass fiber & Polyester /Glass Fiber/ Coconut Fiber / were studied. Various mechanical properties investigations were carried out based on the mechanical properties composite material Polyester / Glass fiber & Polyester /Glass Fiber/ Coconut Fiber / had given good mechanical properties. Overall results when we compare the mechanical properties of composite materials we conclude addition of coconut fiber has given very good mechanical strength. Tensile, Impact and Hardness results were also improved by adding of different fiber (Glass Fiber/Coconut Fiber) in Polyester based composite materials.

6. CONCLUSIONS

The hand layup techniques was used for prepare the Polyester / Fiber composites. The composite was characterized and synthesized through the various mechanical tests and also the results were compared. The different fiber are laminated in Polyester resins laminated were studied. Sundry Mechanical tests investigation was carried out. It was found that the laminated of different fibers in Polyester resin, samples gave highest ultimate tensile vigor, impact and hardness gave good mechanical properties. In this research composite material was yare by hand layup technique. The mechanical properties of Polyester / Glass fiber & Polyester /Glass Fiber/ Coconut Fiber / were studied. Sundry mechanical properties investigations were carried out predicated on the tensile properties and Rockwell hardness.

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