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"FABRICATION AND ANALYSIS OF MECHANICAL PROPERTIES CELLULOSE JUTE FIBER AND GRAPHITE FIBER BASED HYBRID COMPOSITE MATERIAL"

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Abstract – Composite material is one of the most emerging materials of modern era as it provides light weight, high strength to weight ratio, electrical insulation etc. and Hybrid composites have vast area of application due to its better mechanical properties and economically point of view. In today's scenario composite material has competition with its own compatibilities. Aviation industries are most benefitted from composite materials. Hybrid composite materials such as carbon-glass fiber, agamid etc. are used in the fabrication of air craft wings, nose and some other parts that full fill their desired demands. Some other hybrid composites of baggage, cellulose fiber particles, cellulose jute fiber ash, cellulose jute fiber powder, barley husk etc. are most successfully used in automobile industry, furniture industry, and electronic device industry and in dentistry for filling. It is very difficult to fabricate a hybrid composite that provides superior properties over existing composites. Thus the measurement of mechanical properties of fabricated composite material is studied to understand the behavior of composite of material.

In the present work, a hybrid composite of cellulose jute fiber powder and graphite-fiber has been fabricated. For binding cellulose jute powder and graphite-fiber epoxy resin is used. For fabrication hand lay-up method was used and two categories were decided one for 30gm CSP (cellulose jute powder) and another for 45gm CSP. The next step a number of samples were taken from these two categories. Then hardness testing, tensile testing, impact testing and bending test were performed on these selected samples and behavior of 30gm CSP and 45gm CSP were studied.

Key Words: Then hardness testing, Tensile Testing, Impact Testing and Bending test were performed on these selected samples and behavior of 30gm CSP and 45gm CSP were studied.

1. INTRODUCTION

In today's industrialization composite materials are used in various applications like interiors of vehicles, machine parts, aero-space industry, furniture industry, railways, building constructions, ceilings and panels, automobiles, medical industry etc. due there surprising property of light weight, cost effective, easy manufacturing, bio-degradable and environment eco- friendly materials. Composites have the continuous phase with one or more discontinuous phase. The reinforcement material is called discontinuous phase and the continuous phase is known as matrix. Discontinuous phase is stronger than continuous phase. Composite displays the properties of their constituent materials. The size, shape and material reinforcement distribution affect the composite properties. The size, shape and material reinforcement distribution affect the composite properties. Fiber reinforced and natural fillers composite have high qualities and wide area of application in various fields of technical sector [1]. In the thermoplastic like armed and glass fiber conventional synthetic fibers are also used for reinforcement. Due to properties like low density, high thermal insulation, better mechanical properties, environment friendly, disposable, minimal tool wear, easy availability and low price synthetics fibers are used. Synthetic fibers are available in different forms like threads, woven form, wool form, strands etc.

1.2 Definition of Composite

Two or more natural or artificial materials are combined to make a composite. Thus their constituent's useful properties are maximized and their weaknesses are minimized. Most widely used composite is graphite-fibers reinforced plastic (GRP) that combines with graphite fibers with plastic to make a composite material that is tough but not brittle. Composite are best alternatives of metals as they provide higher strength in lighter weight.

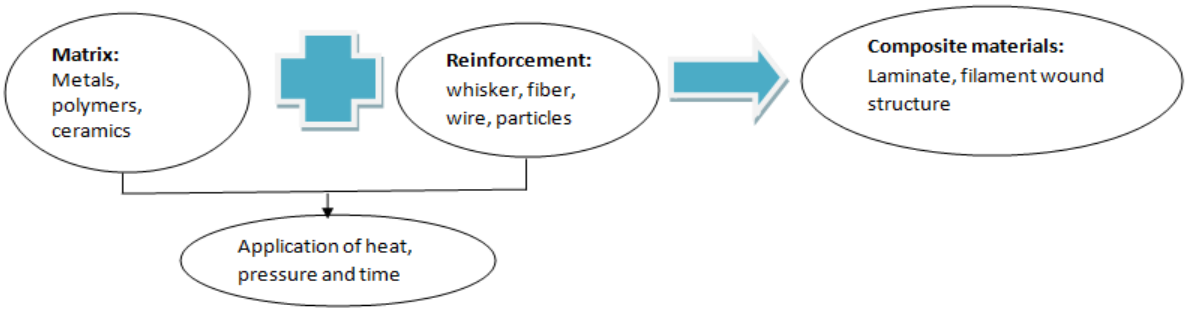


Figure 1.2: Composite materials

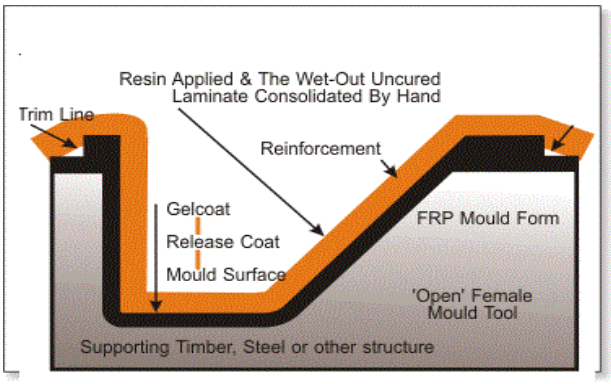
1.3 Hybrid composites

These composites are the composition of two or more different types of reinforcement material, combined in a single matrix form. Hybrid composite materials have the properties of both reinforcement materials in a single matrix. A wide variety of reinforcement material available, but well known common reinforcement material is graphite-fiber. The constituents of hybrid composite material are mixed at molecular level, due to this it forms the more homogenous material and mostly they are anisotropic in nature.

2. Fabrication methods

2.1 Hand lay-up method is the process when fiber reinforcements are placed with resin and allow air dry in room temperature. In this the wooden mold are prepared of required size and gel coating is done to prevent the sticking of resin over the surface. After that with the help of trowel the layers of resin and reinforcement material are formed.

2.2 Compression molding, in this method the heat and pressure is used to fabricate the material. The mold is filled with the plastic material and then the heat and pressure applied to the mold to form the composite material.



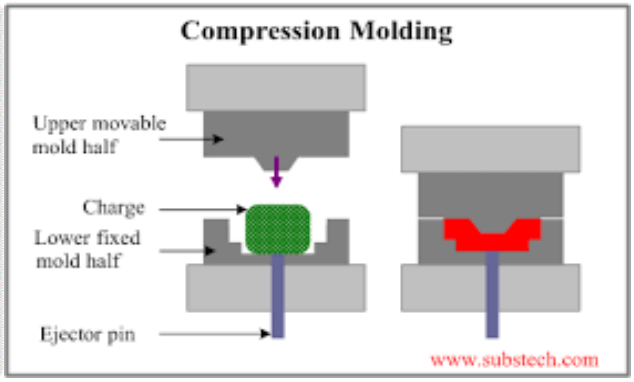


Figure 2.1 Hand Lay-up Method **Figure 2.2 Compression molding Method**

Fibers are categorized in two types one is natural fiber and second is synthetic fiber. Natural fibers are extracting from organic sources, where as synthetic fibers are made from inorganic sources. Natural fibers are the by-product of plants, fruits and crops. They are the waste of plants, fruits and crops after using these organic products. Natural fibers are renewable, cheap, recyclable and biodegradable. Plants like banana, pineapple, jute, bamboo etc.

2.3 Cellulose fiber

Cellulose fiber is a natural crop and it comes from crops . Farming of cellulose fiber is mainly done in all Indian states near by the rives crops. It is also cropped in other countries like Sri Lanka, Indonesia, Thailand and Malaysia. After using the cellulose fiber water the waste is rest called cellulose fiber. Cellulose fiber is agro waste with hard lingo-cellulose content. Composite made from cellulose fiber are used in building material, furniture and fishnets. Cellulose fiber is prominent reinforcement

material in fabrication of various types of polymer matrix composites. Cellulose fiber has low cost, easily and abundantly available, high strength, etc.

2.4 Cellulose jute

Cellulose jute fiber was taken and then sieved to determine the hair sizes in by passing through different sieves. Cellulose jute fiber have no economic value because it is the waste by-product after using cellulose jute and its hair forms. Cellulose jute fiber is costly and the environment friendly. Cellulose jute fiber are can also used as absorbents in water purification system and to treat industrial and municipal waste.

Figure. Cellulose fiber

Figure Graphite fiber

The graphite fiber is the very strong certain class of Carbone fiber the atomic structure is the both are seam is the carbon fiber is the similar to graphite fiber it is the consisting of sheets of the carbon atoms arranged in a regular hexagonal pattern.

3. Experimental Set-Up and methodology

The present study is to fabricate a new type of composite and to measure its mechanical properties so that it can be used in different applications. The methodology as given in a flow chart (figure 3.1) followed in the experimental investigation:

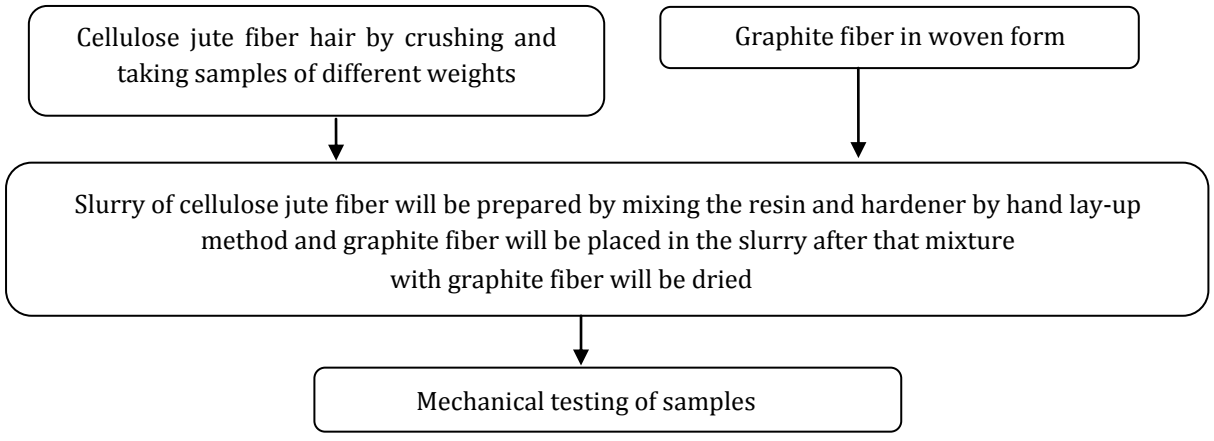


Figure 3.1: Flow diagram of experimentation

3.1 Material used

Material that are used are given below in figure 3.2

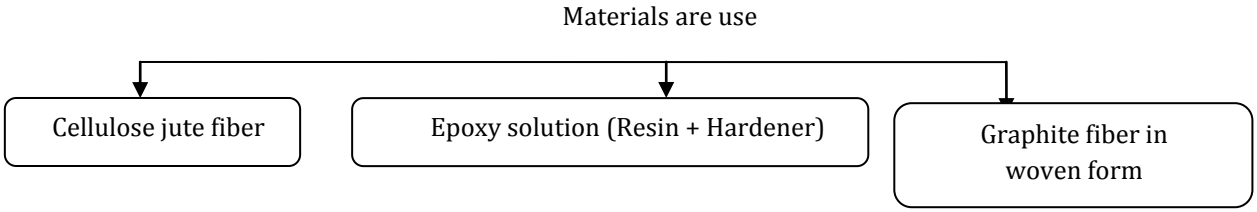


Figure 3.2: Materials used

3.2 Cellulose jute fiber

Table 3.1.1: Grain size ratio for 30gm CSP

S NO.	Grain Size in microns	Material weight in grams
1	600	0.56
2	425	3.33
3	300	2.78
4	150	5.00
5	90	2.22
6	75	1.11
7	Smaller particles below 75 microns	5.00

3.3 Graphite fiber

Graphite fiber is an artificial fiber mostly used as reinforced material in preparing of composite. There several types' graphite fiber is formed like wool, threads and in woven form. Graphite fiber is used in woven form in present work.

Table 3.1.4: Materials Quantity

S. No.	Cellulose jute fiber hair	Reinforced Graphite Fiber	Epoxy solution	
			Resin	Hardener
1	30 gm	Woven form	165gm	165gm
2	45 gm	Woven	170gm	170gm

3.4 Mixing of Resin and Hardener

The adhesive solution epoxy resin and hardener is mix in proportion, by weighing scale resin and hardener are taken 150gm each in beaker and both are mix well by stirring continuously until both the resin and hardener are mixes with each other. Mixture is cured in normal room temperature and pressure. Cured mixture has good thermal and physical stability.

3.5 Mixing of Cellulose jute fiber (CSP) and Epoxy solution

CSP is taken in two weights 30gm and 45gm by weighing scale and these two weights are mixed with resin hardener mixture (160gm each) separately in separate beakers, stir the mixture of CSP and epoxy well until the CSP mixed with in epoxy solution evenly. This mixture is also cured in normal room temperature and pressure.

4. Sample Preparation

Table 3.5Specimen size

S.No.	Test of Properties	Specimen size in mm
1	Tensile Test	170 X 20 X 7
2	Bending Test	76 X 25 X 7
3	Impact Test	65 X15 X7

4.1 Tensile strength test:

This digital and advance machine used for testing tensile strength for various polymer composites plastic material etc. Machine has a maximum capacity of 1000 kgf. A specimen of 170×20×7 mm is taken and fix it in between the grippers of UTM the span length is 90mm.

4.2 Bending strength test

For this test UTM is used. For this test specimen size is 76 × 25×7 mm taken and specimen held in roller type bending set up.

4.3 Impact strength test

A specimen size of 65 ×15×7 mm is taken and notch is prepared at the center of specimen then specimen is kept on the machine. In the next step pendulum is released towards the specimen to measure the impact energy of specimen.

5. RESULT AND DISCUSSION

5.1 Hardness

A Sample piece of 30gm CSP and 45gm CSP is placed one by one over the flat surface, then the probe of hardness tester is pressed at 5 random points over the sample surfaces and readings are noted. Hardness value for both composite samples is taken as the average of 5 random values of hardness for selected sample For 30 gm CSP composite sample the average hardness value is 78.2 while for 45 gm CSP the average hardness value is 80.5

5.2 Tensile strength

Table no. 5.2.1: Maximum load and tensile strength of samples for 30gm CSP:

Specimen	Maximum Load in (N)	Tensile Strength in (Mpa)
1	2305.900	25.273
2	2028.600	22.354
3	1753.200	19.455

Table no. 5.2.2: Maximum load and tensile strength of samples for 45gm CSP

Specimen	Maximum Load in (N)	Tensile Strength in (Mpa)
1	1570.000	17.516
2	1220.200	13.792
3	1435.700	16.092

5.3 Bending Strength

Table 5.3.1: Maximum load and bending strength of samples for 30gm CSP:

Specimen	Maximum Load in (N)	Bending Strength in (Mpa)
1	132.400	24.571
2	182.400	33.467
3	123.600	24.589

Table no. 5.3.2: Maximum load and bending strength of samples for 45gm CSP

Specimen	Maximum Load in (N)	Bending Strength in (Mpa)
1	280.300	48.586
2	210.000	37.264
3	175.600	32.157

5.4 Impact strength

For impact strength test, four samples are taken, two of 30gm CSP and two of 45gm CSP.

Table no. 5.4.1 Impact test showing Impact energy and Impact strength for 30gm CSP:

Sample	Izod Impact Energy	Impact Strength			
1	1.675	**ASTM standards**	**j/m**	**Kg.cm/cm**	**Kg.m/m**
			290.4	31.6327	30.6327
		IS/ISO standards	**j/mm²**	**j/cm²**	**Kj/m²**
			0.055	2.4048	25.0476
2	1.05	**ASTM standards**	**j/m**	**Kg.cm/cm**	**Kg.m/m**
			185	20.8755	20.7755
		IS/ISO standards	**j/mm²**	**j/cm²**	**Kj/m²**
			0.0246	1.7603	16.6032

Table no. 5.4.2 Impact test showing Impact energy and Impact strength for 45gm CSP

Sample	Izod Impact Energy	Impact Strength			
1	1.066	**ASTM standards**	**j/m**	**Kg.cm/cm**	**Kg.m/m**
			213.2	21.7551	21.7551
		IS/ISO standards	**j/mm²**	**j/cm²**	**Kj/m²**
			0.0169	1.6921	16.9206
2	1.066	**ASTM standards**	**j/m**	**Kg.cm/cm**	**Kg.m/m**
			213.2	21.7551	21.7551
		IS/ISO standards	**j/mm²**	**j/cm²**	**Kj/m²**
			0.0169	1.6921	16.9206

6. CONCLUTION

45gm CSP sample was harder than 30 gm CSP. As the weight of CSP increases hardness of hybrid composite increases. 30 gm CSP hybrid composite sample result an improved tensile strength in UTM than 45 gm CSP hybrid composite sample. Load required to break 30 gm CSP hybrid composite sample is also higher than that of 45 gm CSP hybrid composite sample.45 gm CSP hybrid composite resulted an improved bending strength in UTM than 30 gm CSP. Maximum load that a 45 gm CSP sample can bear is higher than that of 30 gm CSP sample. Impact strength of 30 gm CSP hybrid composite is higher than that of 45 gm CSP hybrid composite. Impact energy of 30 gm CSP is 1.752 while for 45 gm CSP it is 1.095.

7. FUTURE SCOPE

Many experiments have been performed to fabricate and to test hybrid composite but limited study is present for cellulose Jute fiber and graphite fiber hybrid composite. Graphite fiber can also be used in some other forms like wool form, thread form etc. In the current work Cellulose jute is used fiber by varying its weight. This hybrid composite can also be fabricated by varying particle size Cellulose jute fiber. In the current work the ratio of resin and hardener are same, this can also be varied to change the properties of hybrid composite. SEM (Scanned Electron Microscopy) can also be used for detailed study of hybrid composite material.

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