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FABRICATION AND MECHANICAL TESTING OF HYBRID FIBERPOLYMER COMPOSITE MATERIALS

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Abstract - *Presently a-days, the common strands from sustainable normal assets offer the possibility to go about as a fortifying material for polymer composites option in contrast to the utilization of glass,carbon and other man-made filaments. Among different filaments, jute is most generally utilized characteristic fiber because of its preferences like simple accessibility, low thickness, low generation cost and attractive mechanical properties. For a composite material, its mechanical conduct relies upon numerous variables, for example, fiber content, introduction, types, length and so forth. Endeavors have been made in this examination work to consider the impact of fiber stacking and introduction on the physical, mechanical and water retention conduct of jute/glass fiber strengthened epoxy based cross breed composites. A half breed composite is a mix of at least two unique kinds of fiber in which one sort of fiber balance the inadequacy of another fiber. Composites of different organizations with three diverse fiber stacking (30wt%, 40wt% and 50wt%) and three distinctive fiber introduction (0°, 3 0° and 60°) are created utilizing basic hand lay-up system. It has been seen that there is a huge impact of fiber stacking and introduction on the execution of jute/glass fiber strengthened epoxy based crossover composites. TOPSIS a multi-criteria basic leadership approach is likewise used to choose the best option from a lot of options. This article displays a review of mechanical and warm properties of the normal manufactured fiber polymer composite. As of late the normal fiber turns out to be increasingly appealing to the scientist since it is a decent exchange of the engineered fiber fortified composite in view of their low thickness, eco-accommodating nature.*

***Key Words*: Natural Composites, Hybrid composites, Mechanical Testing of natural hybrid composites, Water absorption behavior of hybrid composites.**

1. INTRODUCTION

The improvement of composite materials and their related plan and assembling innovations is a standout amongst the most significant advances ever of. Composites are the material utilized in different fields having select mechanical and physical properties and are created for specific application. Composite materials having a scope of focal points over other traditional materials, for example, elasticity, sway quality, flexural qualities, solidness and exhaustion attributes. Due to their various points of interest they are broadly utilized in the airplane business, business mechanical designing applications, similar to machine segments, vehicles, burning motors, mechanical parts like drive shafts, tanks, brakes, weight vessels and flywheels, warm control and electronic bundling, railroad mentors and flying machine structures and so forth.

A. APPLICATIONS OF NATURAL FIBER COMPOSITES

The natural fiber composites can be very cost effective material for following applications:-Building and construction industry: panels for partition and false ceiling, partition boards,wall, floor, window and door frames, roof tiles, mobile or pre-fabricated buildings which can be used in items of natural calamities such as floods, cyclones, earthquakes, etc. Storage devices: post-boxes, storage can, bio-gas containers, etc.

2. PAST WORK

There are a lot of experiment have been done byusing polyester and polypropylene reinforcement with natural fiber such as jute, coir, banana, hemp, cotton etc. Here is interesting to see hybrid fiber composite is made by using e-glass woven/jute fiber combine with epoxy polymer resin how mechanical property of hybrid composite affected.

A. OBJECTIVES OF THE PRESENT RESEARCH WORK

The main objectives of current research work are as follows:

1. Fabrication of bi-directional Jute/glass fiber reinforced epoxy resin based composites.

2. To study influence of fiber loading and fiber orientation on physical, mechanical and water absorption behavior of composites.

3. Evaluate the mechanical properties such as impact strength, flexural strength, tensile strength and water absorption of fabricated composites.

3. MATERIALS AND METHODS

This part portrays the materials required, manufacture technique and the exploratory systems Pursued for their portrayal. It displays the subtleties of the portrayal and tests which the composite examples are exposed to crude materials utilized in the present research work are:-

I- Jute fiber

II-Glass fiber

III- Epoxy resin

IV- Hardener

A. FABRICATION OF COMPOSITE FIBER

The hybrid composite is set up by hand lay-up method.

HAND LAY-UP METHOD:

The manufactures of composite piece are completed by regular hand layup strategy. The bi- directional jute fiber and the E-glass strands are utilized as support and epoxy is taken as Lattice material. E-glass filaments are acquired from Aishna fibers Lucknow India Ltd. The epoxy pitch and the relating hardener are provided by Petro araldite pvt. Limited. Of various arrangements with three distinctive fiber stacking (30wt%, 40wt% and 50wt %) and three diverse fiber introductions (0^0,$30^0$and 60^0) are made. The fiber heaps were sliced to estimate from the jute fiber fabric. The fitting quantities of fiber employs were taken: two for each. At that point the filaments were gauged and likewise the pitch and hardeners were gauged. Epoxy and hardener were blended by utilizing glass bar in a bowl. Care was taken to stay away from arrangement of air pockets. Since the air bubbles were caught in framework may result disappointment in the material. The consequent creation process comprised of first putting a discharging film on the form surface. Next a polymer covering was connected on the sheets. At that point fiber utilize of one kind was put and appropriate rolling was finished. At that point gum was again connected, beside it fiber employ of another sort was put and rolled. Rolling was finished utilizing barrel shaped gentle steel bar. This technique was rehashed until eight exchanging filaments have been laid. On the highest point of the last utilize a polymer covering is done which serves to guarantee a divine being surface completion. At last a discharging sheet was put on the main; a light rolling was done. At that point a 10 kgf weight was connected on the composite. It was left for 24 hrs to permit adequate time for relieving and consequent solidifying. Figure 3.1a and b shows bidirectional jute fiber and glass fiber respectively. Similarly, Figure 3.2 shows jute/glass fiber reinforced epoxy hybrid composite. Thenitty gritty synthesis and assignment of the composites aredisplayed in Table 3.1 the cast of every composite is restored under a heap of around 40 kg for 24 hours. At long last the examples of reasonable measurement are cut with the assistance of hacksaw for portrayal and testing.

Figure 3.1 Bidirectional Jute fiber

Figure 3.2 Bidirectional Glass fiber

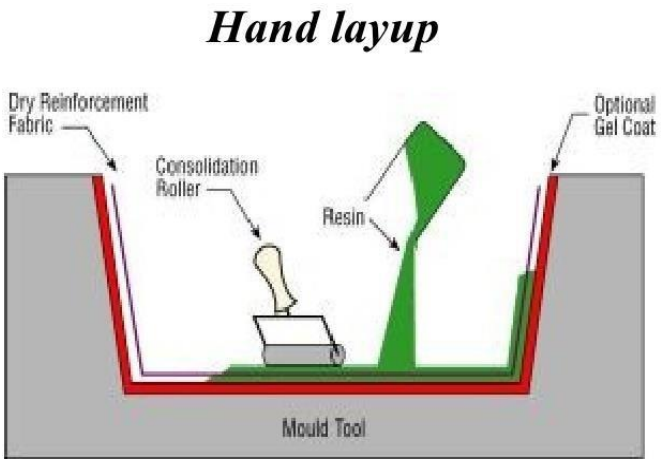

Figure 3.3. Hand layup method

(a)

(b)

Figure 3.4Bidirectional (a) glass fiber and (b) jute fiber

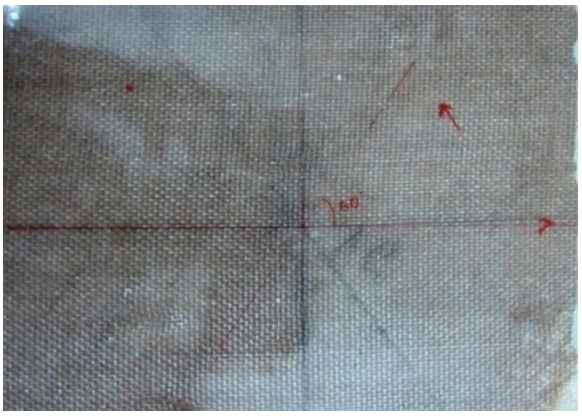

Figure 3.5Bidirectional Glass/ Jute fiber reinforced hybrid polymer composites

Table 3.1Designation of Composites

Composites	Position (degree)	Configuration
A1	0	Epoxy (70wt %) + Glass (15 wt %) + Jute (15wt%)
A2	0	Epoxy (60 wt %) + Glass (15 wt%) + Jute (25wt%)
A3	0	Epoxy (50 wt %) + Glass (15 wt %) + Jute (35wt%)
A4	30	Epoxy (70 wt %) + Glass (15wt %) + Jute (15wt%)
A5	30	Epoxy (60 wt %) + Glass (15 wt %) + Jute (25wt %)
A6	30	Epoxy (50 wt %) + Glass (15 wt %) + Jute (35wt %)
A7	60	Epoxy (70 wt%) + Glass (15wt %) + Jute (15wt %)
A8	60	Epoxy (60 wt %) + Glass (15 wt %) + Jute (25wt %)
A9	60	Epoxy (50 wt %) + Glass (15 wt %) + Jute (35wt %)

4. RESULTS & DISCUSSIONS

In this chapter we discuss the physical, mechanical and water absorption behavior of the jute/glass hybrid fiber polymer composite material. In this chapter we calculate the result of various mechanical properties and data of various test are tabulated here. This include the evaluation of tensile strength, density, flexural strength, and impact, strength and water absorption of the sample. The understanding of the outcomes and the examination among different composite examples are likewise introduced.

A. Physical and Mechanical Characteristics of Composites

a. Effect of Fiber Loading and Orientation on Density of Composites

The presence of void substance in the composites altogether decreases the mechanical and physical properties of the composites. The physical properties of a composite material framework can be as significant as mechanical properties in evaluating appropriateness for a specific application. Thickness assumes a key job for structuring a designing segment or choosing the use of a material especially where weight is a significant factor. Subsequently, it is important to decide the thickness of the composites created for this examination. Table 4.1 demonstrates the hypothetical thickness, exploratory thickness and the relating void substance.

Table 4.1 Void fraction of hybrid composites

Composites	Theoretical density (gm/cm)	Experimental density (gm/cc)	Volume fraction of voids (%)
A1	1.290	1.31	1.550
A2	1.301	1.29	0.8455
A3	1.315	1.321	0.4562
A4	1.30	1.310	0.7692
A5	1.31	1.302	0.6106
A6	1.335	1.314	1.573
A7	1.302	1.321	1.459
A8	1.325	1.312	0.9811
A9	1.335	1.326	0.6741

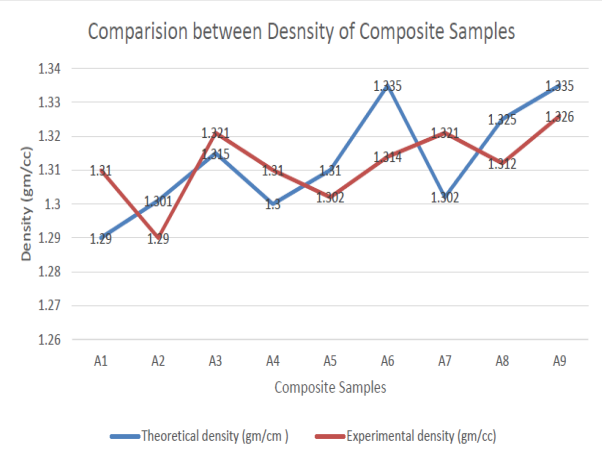

Figure 4.1 Void fraction of hybrid composites

b. Effect of Fiber Loading and Orientation on Tensile Properties of Composites

The effect of fiber loading and orientation on the tensile strength of the hybrid fiber composite show in table and graph. In this test we find that the tensile strength of the composites decrease with increase the fiber loading and orientation because of poor adhesion between matrix and fiber. It's observed that the maximum tensile strength is for composite with 0 orientations and 30 Wt % fibers loading. Table 4.2 show the effect of fiber loading and orientation on the tensile strength of jute/glass hybrid fiber polymer composites. In this table show that I takes 3 set of each sample in order to finding the exact value of each sample and average value of samples is further used in comparing the tensile strength of each samples graphically.

Table4.2 show effect of fiber loading and orientation on composites

Composites	Tensile test			Average Tensile Strength (MPa)
	Trial 1	Trial 2	Trial 3	
A1	141	139	142	140.66
A2	124	122	121	122.33
A3	94	92	91	92.33
A4	123	120	118	120.33
A5	93	91	90	91.33
A6	94	96	95	95
A7	76	79	78	77.66
A8	64	66	65	65
A9	72	74	74	73

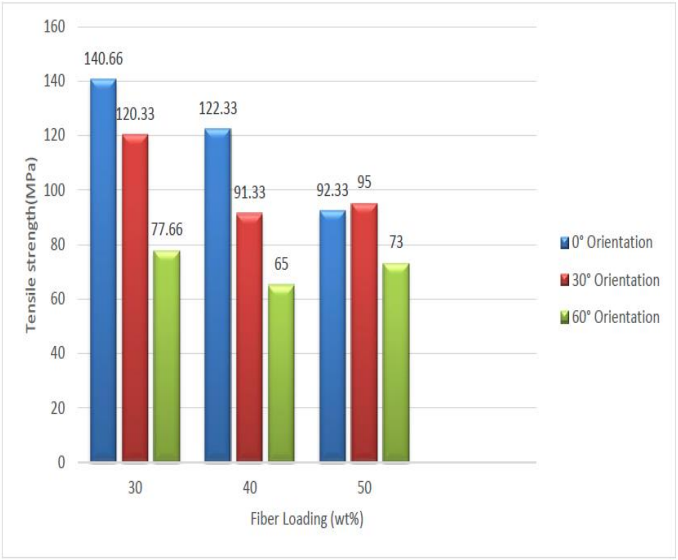

Figure 4.2Effect of fiber loading and orientation on tensile strength of composites

c. Effect of Fiber Loading and Orientation on Flexural Properties of Composites

The effect of fiber loading and orientation on the flexural strength of the composite show in table 4.4 and graph 4.5.The flexural strength of the jute/glass hybrid fiber polymer composite increased with increase with fiber loading up to 40 wt% and after that decrease with fiber loadingirrespective to fiber orientations .But in case of fiber orientations the flexural strength of composite in maximum for 40 wt % fiber loading with 30° fiber orientation.

Table 4.3Effect of fiber loading and orientation on flexural strength of composite

Composites	Flexural test			Average Flexural Strength (MPa)
	Trial 1	Trial 2	Trial 3	
A1	149	151	147	149
A2	234	232	235	233.66
A3	168	164	166	166
A4	237	233	235	235
A5	296	293	295	294.66
A6	170	169	168	169
A7	230	229	231	230
A8	246	244	245	245
A9	162	160	163	161.66

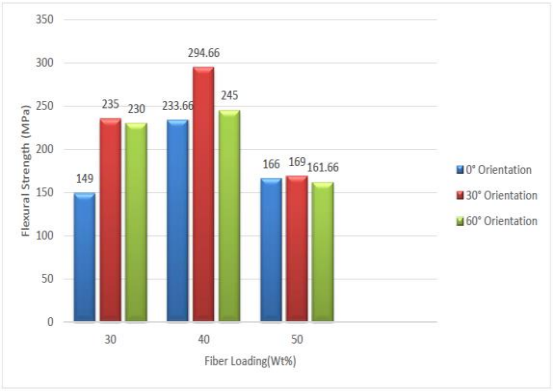

Figure 4.3Effect of fiber loading and orientation on flexural strength of composites

d. Effect of Fiber loading and Orientation on Impact strength of Composites

Impact strength of jute/glass hybrid fiber polymer composites is show in tables 4.6 calculated from Charpy testing ASTM E23 standard is used .It is observe that the impact strength of the composites significantly increase with increasing the fiber loading in the composite. Impact strength is maximum at 50 wt% fiber loading and 30° orientation. Impact strength is decrease during 30° to 60° orientation and increase from 0° orientation to 30° orientation with respect offiber loading.

Table 4.4Effect of fiber loading and orientation on Impact strength of composites

Composites	Impact (Charpy) test			Average Impact Energy (joules)
	Trial 1	Trial 2	Trial 3	
A1	257	254	260	257
A2	260	258	256	258
A3	262	265	263	263.66
A4	258	256	259	257.66
A5	262	264	266	264
A6	265	263	267	265
A7	254	255	257	255.33
A8	260	257	263	260
A9	264	262	258	261.33

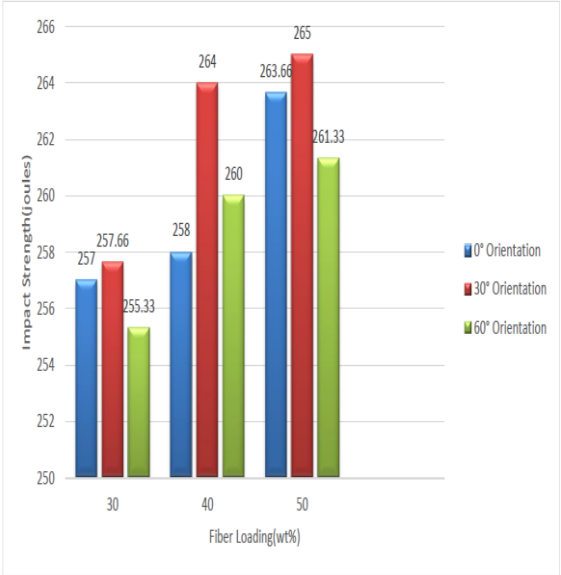

Figure 4.4 Effect of fiber loading and orientation on Impact strength of composites

B. Water Absorption Behavior of Composites

Water absorption test is important in order to determine the water absorptivity of material. The percentage of increased in weight of the hybrid fiber composite with respect of time show in the given table 4.5.It is also find that the percentage of water absorptivity also increased with increased fiber content in the hybrid fiber composites irrespective of fiber orientation. The behavior of water absorption in composites is caused by jute fiber. There are three main reason for water absorptivity in the jute/glass hybrid fiber polymer composites such as lumen, the cell divider and the holes among fiber and resin on account of powerless interface grip is found because of which water can reside in composite. During the observation it is found that at 50 wt% fiber loading water absorption is maximum irrespective to fiber orientation. To the extent impactof fiber introduction on the water ingestion of composites is worried there isn't much impact is watched.

Table 4.5 Effect of immersion time on water absorption properties of composites

Composites	Water absorption (%)										Average water absorption(%)
	24 Hrs	48 hrs	72 hrs	96 hrs	120 hrs	144 hrs	168 hrs	192 hrs	216 hrs	240 hrs	
A1	1.6	1.8	2.10	2.60	2.90	3	3.15	3.25	3.40	3.50	2.73
A2	1.8	2.35	2.83	3.4	3.91	4.2	4.5	4.72	4.89	4.95	3.75
A3	2.98	3.88	4.7	5.35	5.96	6.15	6.23	6.36	6.40	6.48	5.45
A4	1.8	2.3	2.6	3.2	3.8	4.0	4.3	4.6	4.7	4.8	3.63

		3	0	5	6	5	0		5		
A5	2.84	3.2	3.5	3.9	4.10	4.35	4.80	5.10	5.15	5.19	4.21
A6	4.10	4.40	4.80	5.5	6.10	6.40	6.55	6.70	6.83	6.95	5.83
A7	1	1.4	1.7	1.8	1.85	1.96	2.10	2.32	2.45	2.54	1.91
A8	2.10	2.40	2.65	3.05	3.40	3.70	4.10	4.32	4.5	4.60	3.48
A9	2.40	3.20	3.90	4.10	4.40	4.66	5.70	5.84	5.90	5.94	4.60

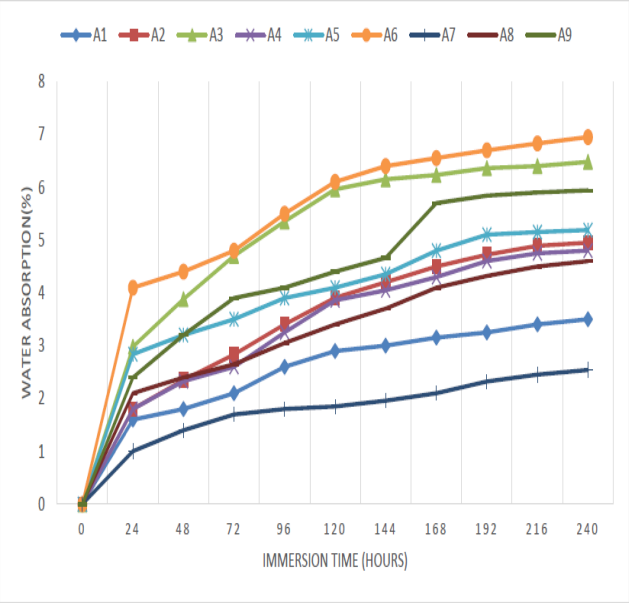

Figure 4.5. Effect of immersion time on water absorption properties of composites

5. CONCLUSIONS

In this present work jute/glass fiber reinforced epoxy based hybrid composites is manufactured by using hand lap method. During this experimental study the effect of fiber loading and orientation on physical, mechanical, water absorption of hybrid fiber reinforced polymer composites leads to following conclusions.

1. The fruitful creations of another class of epoxy based hybrid composites reinforced with jute and glass fiber have been finished. The present examination uncovered that fiber stacking and introduction essentially impacts the various properties of composites. The density of the composites change with increasing fiber loading and the orientation of the fiber less influence onthe density of composite. Due to the presence of voids in the composite there is the difference between the theoretical and experimental densities. It can be seen that the voids fraction increase with increase the fiber loading in the composites.

2. Tensile strength of the composites decrease with increase the fiber loading and orientation because of poor adhesion between matrix and fiber. It's observed that the maximum tensile strength is for composite with 0 orientations and 30 Wt % fibers loading. The flexural strength of the jute/glass hybrid fiber polymer composite increased with increase with fiber loading up to 40 wt% and after that decrease with fiber loading irrespective to fiber orientations .But in case of fiber orientations the flexural strength of composite in maximum for 40 wt % fiber loading with 30° fiber orientation.

3. It is observe that the impact strength of the composites significantly increase with increasing the fiber loading in the composite. Impact strength is maximum at 50 wt% fiber loading and 30° orientation. Impact strength is decrease during 30° to 60° orientation and increase from 0° orientation to 30° orientation with respect of fiber loading.

4. It is also find that the percentage of water absorptivity also increased with increased fiber content in the hybrid fiber composites irrespective of fiber orientation. The behavior of water absorption in composites is caused by jute fiber. There are three main reasons for water absorptivity in the jute/glass hybrid fiber polymer composites such as lumen, the cell divider and the holes among fiber and resin on account of powerless interface grip is found because of which water can reside in composite. During the observation it is found that at 50 wt% fiber loading water absorption is maximum irrespective to fiber orientation. To the extent impact of fiber introduction on the water ingestion of composites is worried there isn't much impact is watched.

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