INVESTIGATING THE MECHANICAL PROPERTIES OF HYBRID FIBER POLYMER COMPOSITE FOR STRUICTURAL APPLICATIONS

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***Abstract*: This article represents an overview of the mechanical characteristics of the natural-synthetic fiber-polymer composite. Recently the natural fiber becomes more attractive to the researcher because it is a good alternative of the synthetic fiber reinforced composite because of their low density, eco-friendly nature, low cost, recyclable. Now the natural fiber plays a very important role in developing automobile parts and structural application. This article shows that hybrid fiber polymer composite is more useful in the production of automobile parts and structural application due to their excellent mechanical and thermal characteristics and replace synthetic material from the market and save the environment.**

***Keywords*: Mechanical Properties, Thermal properties, Composite, Hybrid, Natural Fiber**

1. Introduction

The natural fiber is very useful and easily available from the natural resources like agriculture, animal, plant but synthetic recyclable but mechanical properties are better than natural fiber. So many researchers developed a material called composite material. A composite is an auxiliary material that comprises at least two joined constituents that are consolidated at a perceptible dimension and are not solvent in one another. One constituent is known as the strengthening stage and the one in which it is inserted is known as the grid. The strengthening stage material might be as strands, particles, or pieces. The network stage materials are commonly persistent. Autar K Kaw [1]. Matrix and Reinforcement both are an integral part of composite materials. The reinforcement and matrix are the phase of the composite which are insoluble with each other and differ in physical form and chemical composition. Matrix is used to hold the reinforcement, stopping the crack propagation, protect the reinforcement from the external environment and provide good strength of the composite. The composites are classified on the basis of its matrix and reinforcement. Matrix-based composite is polymer matrix composite, metal matrix composite, and ceramic composites. Reinforcement composites are classified as filler composites, flake composite, fibrous composites, and particulate composites. Fabulous composites are divided into the single and multilayered composite. While laminates and hybrid both are the part of multilayered composites. Rahul Shrivastava et al. [2]. Fiber reinforced polymer composite has much structural application due to its low weight, easy fabrication, low price and good mechanical characteristics as compared to polymer resin. When the increased the natural fiber in composites the thermal conductivity reduced so it is desirable for heat flux dissipation for electronics packaging components. The use of natural fiber reduced the weight of the specimen by 10% and the energy needed for production by 75-80% as compared to fiberglass reinforced material component. M.SAKTHIVEI et al. [3]. Natural fiber such as banana, hemp, jute, sisal, kenaf etc.used as a reinforcement for polymer composites. When they are used as a filler in composite, they provide good mechanical properties as compare to synthetic fiber. when adding the compatibility agents in composite the mechanical characteristics and weathering stability improve because of making covalent interaction between a surface hydroxy group of the natural fiber and compatibilizer. The additive MAH-PP increase the tensile strength, flexural strength, and stiffness of the composites. Marcel Ionel Popa et al. [4]. When looking at information from changed sources, it ought to be viewed as that various factors that are not constantly revealed have an impact on fiber properties. These incorporate testing speed, measure length, dampness substance, and temperature. By and large quality increments with expanding dampness substance and diminishes as temperature builds; Young's modulus diminishes with dampness content. Here and there it is likewise indistinct in the writing concerning whether the tests have been directed on single strands (single cells) or on fiber groups (some of the time alluded to as specialized filaments). Estimation of properties is commonly founded on the all-out cross-segment of a fiber or fiber pack, in any case, single filaments have a focal empty lumen which takes up a noteworthy extent of the cross-sectional territory. The portion of the cross-sectional region taken up by the lumen has been observed to be, for instance, 27.2%, 6.8% and34.0% for sisal, flax, and jute individually thus it could be viewed as that estimations of solidarity and solidness acquired not considering are underestimations to a similar degree. K.L. Pickering et. al [5]. Factors affecting the mechanical and thermal properties of NFC are:

· Selection of fiber

· Selection of matrix

· Manufacturing method used for composite

· Moisture contains

· Chemical and mechanical treatment

· Interfacial molecular bonding

The mechanical characteristics of natural fiber shown in Table 1. In this table, it is showing that the E-glass fiber has good tensile strength as compared to all natural fiber and Young's modulus of the flax is more than all fiber. So natural fiber mixed with synthetic fiber in order to obtain the characteristics of both and reduced weight, cost of the specimen.Sanjay M Ra et al. [6]

Table 1: Physical Properties of Natural Fibers

Fibers	Tensile Strength (MPa)	Young's modulus (GPa)	Elongation at Break (%)	Density (g/cm3)
Abaca	400	12	3-10	1.5
Bagasse	350	22	5.8	0.89
Bamboo	290	17	-	1.25
Banana	529-914	27-32	5.9	1.35
Coir	220	6	15-25	1.25
Cotton	400	12	3-10	1.51
Curaua	500-1150	11.8	3.7-4.3	1.4
Flax	800-1500	60-80	1.2-1.6	1.4
Hemp	550-900	70	1.6	1.48
Jute	410-780	26.5	1.9	1.48
Kenaf	930	53	1.6	-
Pineapple	413-1627	60-82	14.5	1.44
Ramie	500	44	2	1.5
Sisal	610-720	9-24	2-3	1.34
E-glass	2400	73	3	2.55

1.1 Natural fiber Reinforced Polymer Composites

Flexural Strength of the jute fiber epoxy based composite is good as compare to other treated or non treated composite the flexural strength of jute fiber epoxy based composite after surface treatment is 89 MPa which is greater than other treated composite. The impact strength of non treated jute /epoxy composite is more than all other non treated composite but after surface treatment of the composite, the impact strength also decreases. The tensile strength of the non treated jute fiber epoxy based composite is better than non treated sisal and banana based composite after the surface treatment of composite by NaOH the tensile strength improve. During the surface treatment by NaOH the surface area interaction increases between fiber and resin which causes tensile strength increase. Jai Inder Preet Singh et al. [7]. Most of the mechanical properties depend on chemical constituent (crystalline cellulose, non-crystalline cellulose, and lignin) of the natural fiber reinforced polymer composite. The flammability of natural fiber restricts its application in many sectors (electronics, automotive, maritime and aircraft industries). Carbon-based polymer composite has good thermal conductivity as compared to the natural fiber reinforced polymer composite. In hemp fiber reinforced polymer composites, the phosphorus is used to reduce the flammability. It is noticed that when we added fire retardant into polymer matrix the mechanical properties changed. Kin-takes Laua et al. [8]. Carbon fiber composite is used in many industries like automobile, sporting goods, aerospace, etc due to its high strength, high modulus, low density, high-temperature resistance. Carbon fibers are unidirectional reinforcement; the carbon fibers are arranged in such a way that composite is stronger in the direction where the load is applied. Saira Taj et al. [9]. Sisal fiber reinforced polymer composite the mechanical properties such as tensile strength, tensile modulus, flexural strength, flexural modulus, and impact strength is maximum when we used epoxy polymer as compare to thermosets used including polyester, vinyl ester, and phenolic resin. K. Senthilkumar et al.[10]Impact strength, density, and hardness of the banana reinforced epoxy polymer composite is good as compare to coir, sisal polymer composite. The water absorption capacity of the banana reinforced polymer composite is about 10% of its mass and the percentage of gain water by coir, sisal polymer composite is 9%,5% of its mass. The energy absorbed by the banana reinforced polymer composite during impact test is 5 joules although the energy absorbed by the coir and sisal reinforced composite during impact test is 4 joules so impact strength is good for banana fiber-polymer composite. M.SAKTHIVEl1 et al. [3]. The Young's modulus and the Tensile strength of bamboo fibers increased by 14% and 38%, respectively of the bamboo fiber reinforced epoxy composite when it is chemical (6%wt. NaOH) treated and flexural modulus of the bamboo reinforced polymer composite is higher when length and content of the bamboo fiber increased**.** Kai Zhang et al. [11]. The tensile, compressive and bending strength of the jute fiber reinforced polymer (epoxy) composite increase with increase the fiber In composite and the impact strength of the composite is not changed when the amount of fiber increased. The jute fiber reinforced polymer composite is used in construction purposes, automobile industry, window and door frames, roof tiles, etc. Asheesh Kumar et al. [12]. Synthetic fiber mostly reinforced with polypropylene polymer composite because of its good properties, E-glass fiber mixed with polypropylene to provide good mechanical properties at low cost in fiber reinforced plastic industries. S-glass fiber reinforced polypropylene composite used in aircraft components and missile casings because of it the highest tensile strength among all fibers. Arpitha. G. R et al. [13].

1.2 Hybrid Fiber Reinforced Polymer Composite

The tensile and flexural strength of the jute, pineapple leaf fiber, and glass reinforced polyester composite is less than the jute, pineapple, and glass reinforced epoxy composite. So in many structural applications epoxy is used as a matrix in order to achieve better tensile flexural strength. When we increase the fiber content in composite the flexural and tensile strength of hybrid fiber reinforced polymer composite increased. M. Indra Reddy et al.

The glass fiber is notwithstanding with high temperature due to its low melting temperature so carbon fiber is used as a matrix in reinforced polymer composite. Fibre reinforced polymer with a mixture of glass fiber and carbon fiber increased the strength and stability of the material. The small amount of carbon fiber will reduce the weight and cost of the material. The low weight of the material will reduce the 8-10% total weight of the aircraft which Causes the fuel consumption also be reduced. P. M. Bhagwat et al. [15]. The warm properties, for example, warm conductivity, warm diffusivity, and explicit warmth limit of mixture composite are influenced by the synthetic treatment of fiber and filler focus. The warm conduct of cross breed pineapple leaf fiber (PALF) and glass fiber fortified polyester composites has been assessed that the substance treatment of fiber diminishes the composite warm contact opposition. In Banana and Pineapple leaf fiber strengthened polyester composites the warm conductivity of cross breed composite increment with increment the temperature and reduction with increment volume division the fiber in the composite. The particular warmth limit of fiber-fortified polyester composites estimated in the scope of 30◦C — 120◦C and find that the particular warmth of composite reductions with expanding volume portion of filaments characteristic fiber half and half composite is utilized in numerous applications where protection are required, for example, vehicle enterprises, electronic bundles, building development, and game merchandise and so on. P. V. Ch. R. K. Santosha et al. [16]. The natural hybrid fiber polymer composite now used as a biomaterial in medical science for an implant of human body bone replacement. The properties required for bio-material are corrosion resistance, resistance to implant wear, low weight, etc. Amid the wear investigation of 12%, 24% and 36% of Hybrid Fiber (Natural fiber-Sisal, Jute and Hemp) polymer composite material it is discovered that 36 % Hybrid Natural filaments Polymer Composite Material has greatest wear rate, Friction Force and Weight Loss as contrast with 12% and 24% cross breed fiber polymer composite so expanding the level of normal fiber increment the wear rate of example. So as to lessen the heaviness of the example the level of fiber increment in the composite. Henceforth, the heaviness of 36% of Hybrid regular fiber polymer composite is under 12%,24% half and half characteristic fiber polymer composite, so we can utilize this sort of low weighted cross breed common fiber polymer composite as an elective material for Human Orthopedic Implants. Dr. A Thimmana Gouda et al. [17].

2. 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

2.1 MATERIALS

2.1.1 JUTE FIBER:

Jute filaments are long (1 to 4 meters), luxurious, radiant and brilliant darker in shading. As opposed to most material filaments which comprise basically of cellulose, jute strands are part cellulose, part lignin. Cellulose is a noteworthy segment of plant strands while lignin is a noteworthy segment of wood fiber; jute is consequently somewhat a mate. The strands can be separated by either organic or concoction retting forms. Given the cost of utilizing synthetic substances to take the fiber from the stem organic procedures are all the more broadly rehearses. Organic retting should be possible by either by stack, soak and lace forms which include distinctive strategies of packaging jute stems together and absorbing water to help separate the strands from the stem before stripping. After the retting procedure, stripping starts. In the stripping procedure, non-stringy issue is scratched off, leaving the filaments to be hauled out from inside the staminal fiber and mostly wood. Jute fiber has quality, minimal effort, toughness and adaptability.

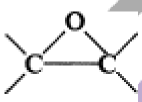
2.1.2 GLASS FIBER:

A fiberglass is a type of fiber-strengthened plastic where glass fiber is the fortified plastic. This is the reason may be why fiberglass is otherwise called glass strengthened plastic or glass fiber fortified plastic. The glass fiber is generally leveled into a sheet, haphazardly orchestrated or woven into a texture. As indicated by the utilization of the fiberglass, the glass strands can be made of various kinds of glass.

Fiberglass is lightweight, solid and less weak. The best piece of fiberglass is its capacity to get formed into different complex shapes. This essentially clarifies why fiberglass is broadly utilized in baths, pipes, electrical insulation, airplane, material, and different applications. Materials with high-temperature protection give a powerful warm hindrance to modern gaskets. Since fiberglass is solid, safe and offers high warm protection, fiberglass is one of the generally favored materials in modern gaskets. They give a superior protection as well as help in securing the hardware, monitoring the vitality and guarantee the wellbeing of the expert workforce.

2.1.3 POLYMER: EPOXY RESIN

Epoxy resin exit in the cross linkable materials group. The epoxy bunch is portrayed by its reactivity towards both nucleophilic and electrophilic species and it is in this manner open to a wide scope of reagents or relieving specialists. Such restoring specialists are of two sorts: they might be either impetuses or hardeners. Impetuses are generally drawn from tertiary amines or Lewis acids, and they work by starting the ionic polymerization of the epoxy compound to create polyether structures. In this work we used epoxy AW 106 made by Petro araldite pvt. Limited Company.



(1)

2.1.4 HARDENER:

In this current work Hardener (araldite) HV 953 IN is used. This has a viscosity of 12-25 poise at 25^{0}C.Epoxy gums are entirely steady liquids with moderately long timeframes of realistic usability. It is just when blended with an epoxy hardener that they can fix legitimately. Whenever connected onto a story without the hardener, the pitch would remain a close fluid uncertainly and couldn't change into a strong ground surface framework. In contrast to paints, which depend on the dissipation of dampness to in the long run solidify into a slender film, an epoxy floor covering accomplishes its superior defensive qualities by experiencing a controlled compound response that happens between deliberately adjusted gum and hardener segments.

2.2 FABRICATION OF COMPOSITE FIBER

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

2.2.1 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.The nitty gritty synthesis and assignment of the composites are displayed 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.

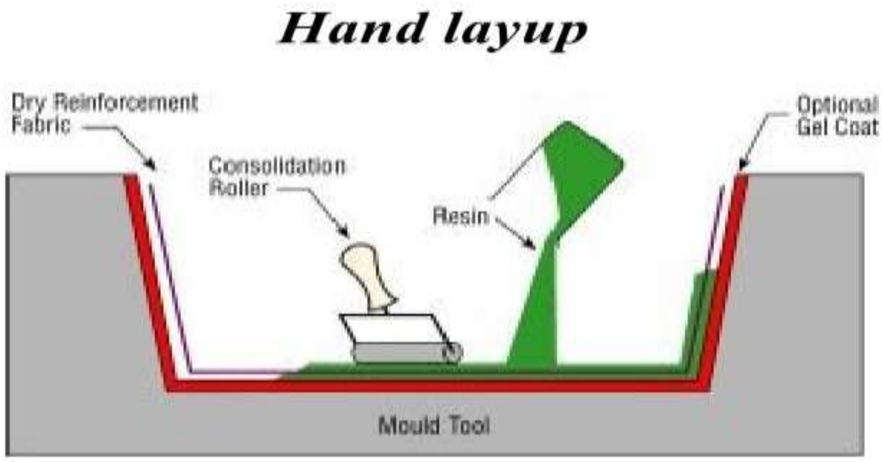


Figure 2.1Hand layup method

(a) **(b)**

Figure 2.2 Bidirectional (a) glass fiber and (b) jute fiber

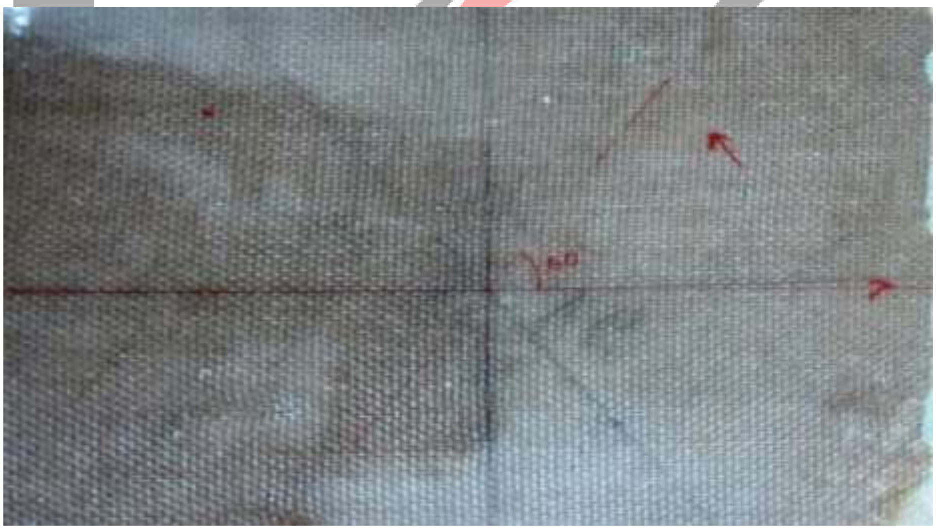


Figure 2.3 Bidirectional Glass/ Jute fiber reinforced hybrid polymer composites

Table 2.1 Designation of Composites

Composites	Position (degree)	Configuration
A1	0	Epoxy (70 wt %) + 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 (15 wt %) + 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 %)

3. RESULTS AND 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.

3.1 Physical and Mechanical Characteristics of Composites

3.1.1 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 3.1 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

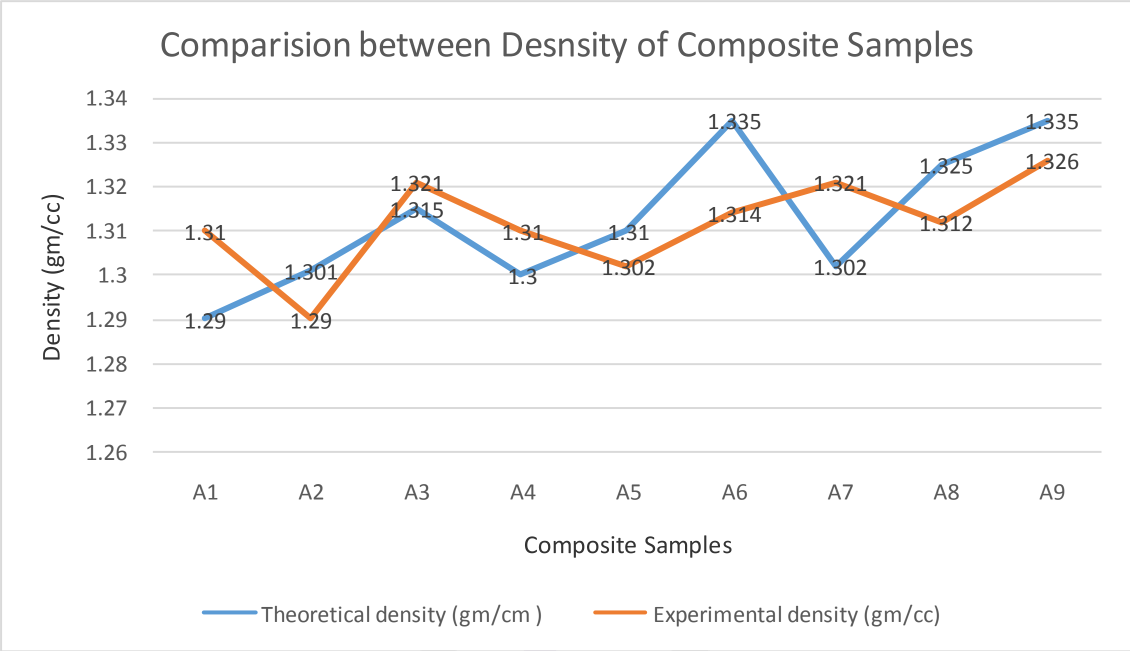


Figure 3.1 Void fraction of hybrid composites

The density of the composites change due to fiber loading it is observe from the above table and the orientation of the fiber less influence on the 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.

3.1.2 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 .

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

Table3.2 show effect of fiber loading and orientation on composites

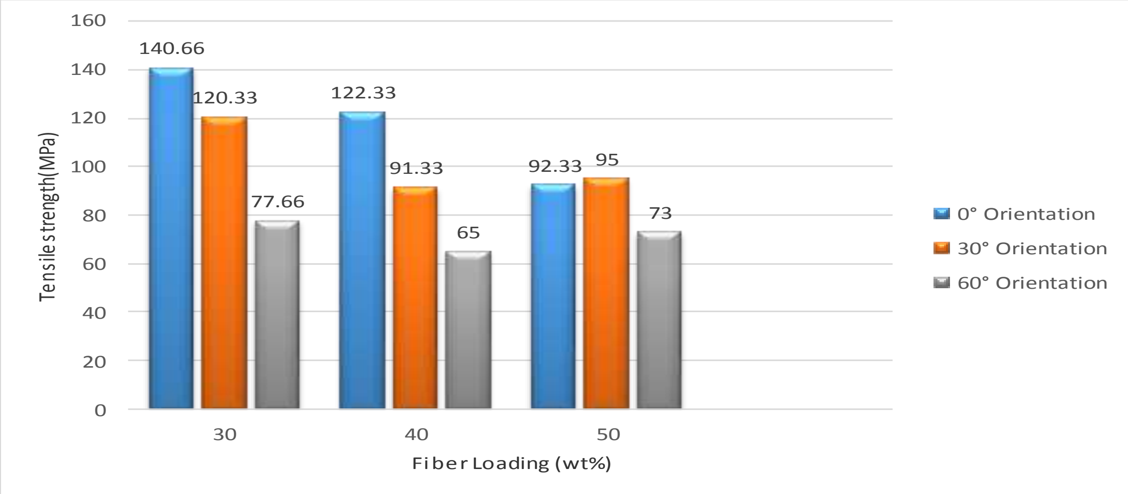


Figure 3.2 Effect of fiber loading and orientation on tensile strength of composites

3.1.3 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 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.

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

Table 3.3Effect of fiber loading and orientation on flexural strength of composites

Figure 3.3Effect of fiber loading and orientation on flexural strength of composites

3.1.4 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 of fiber loading.

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

Table 3.4Effect of fiber loading and orientation on Impact strength of composites

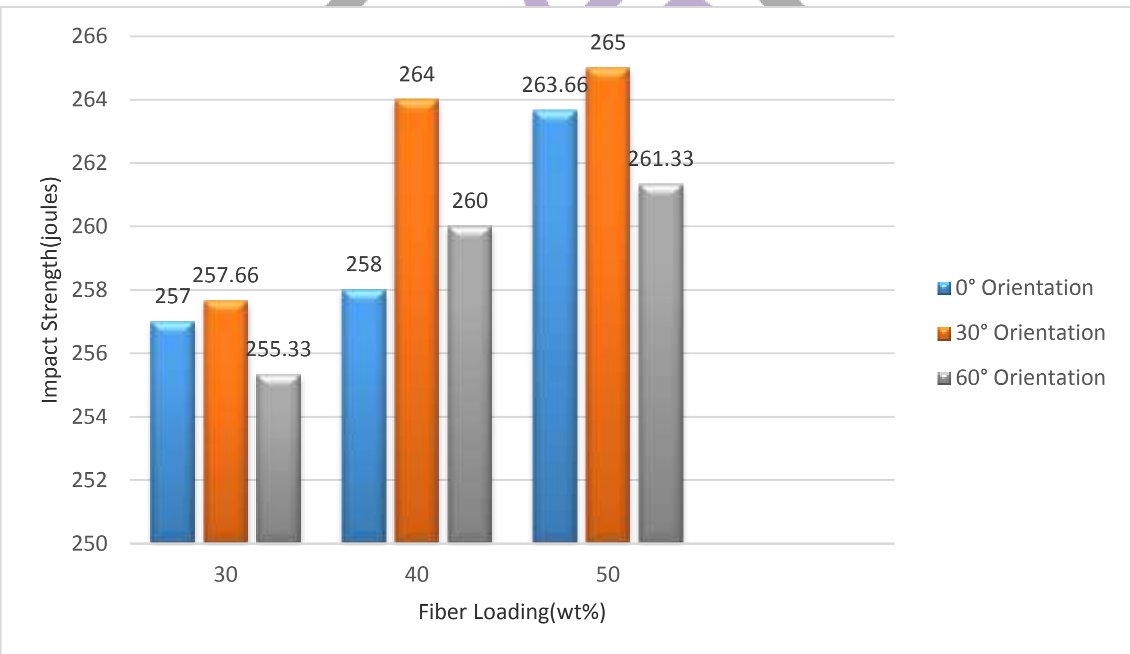


Figure 3.4 Effect of fiber loading and orientation on Impact strength of composites

3.1.5Water 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 impact of fiber introduction on the water ingestion of composites is worried there isn't much impact is watched.

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	2.33	2.60	3.25	3.86	4.05	4.30	4.6	4.75	4.8	3.63
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

Table3.5 Effect of immersion time on water absorption properties of composites

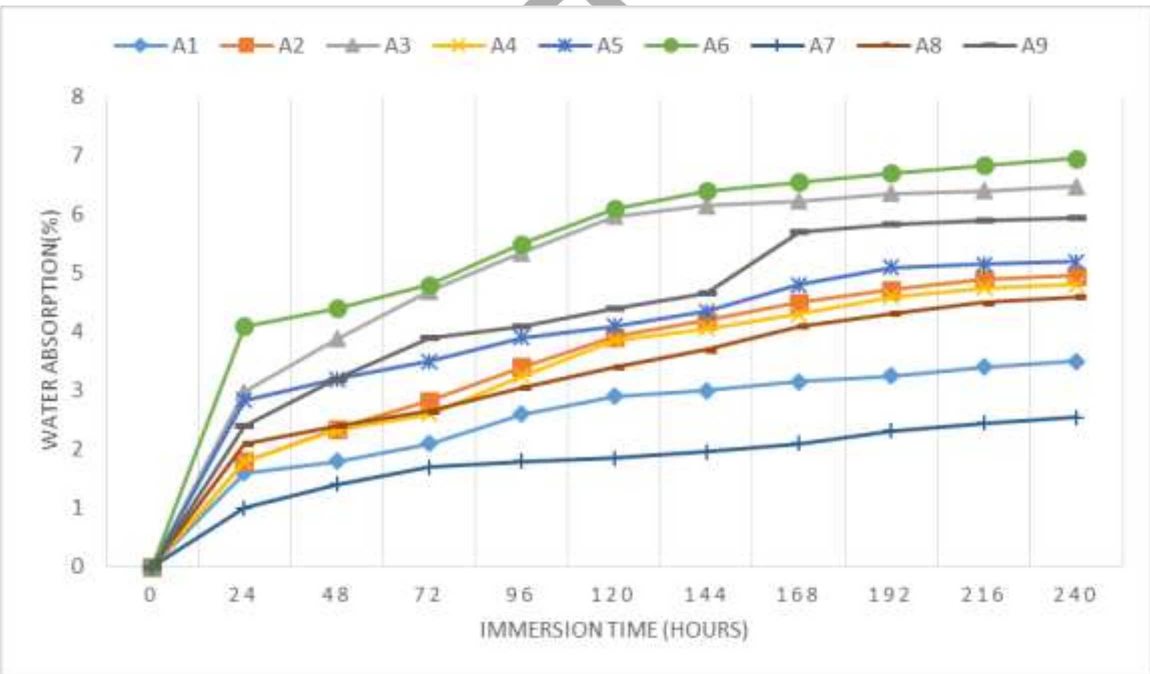


Figure 3.5 Effect of immersion time on water absorption properties of composites

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 on the 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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