Evaluation of Polymer Matrix Composite Material using Natural and Synthetic Fiber

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Abstract: **Fiber are synthetic and they are non-biodegradable. Natural fiber another hand also possess high strength to low weight ratio in regard of certain mechanical characteristics such as flexibility, tensile it also possesses good behaviour as natural fibers are obtained from agricultural waste, plants etc. In composite material strength, life time, are decreased due to major fact of water absorption. In order to improve strength composites going for a hybrid composite with help of glass fiber, bagasse from agricultural waste, sisal. In these composite glass fiber is used as an outer laminate and on the inner natural fibers to reduce moisture absorption. The behaviour is studied with help of testing methods such as hardness, density, moisture absorption, impact.**

Keywords: Glass, Bagasse, Sisal, ASTM, PVA, NaOH.

1. INTRODUCTION:

In recent trends Fiber Reinforced Polymer Composites[FRPC] possess greater advantages than other materials because of both mechanical and physical characteristics and also in regards of manufacturing cost of the composite, the availability in the nature, the processing method employed FRPC are far better than materials. In these FRP fibers are the force withstanding elements they provide strength where areas the resin are responsible for keeping the element aligned on that particular position. The rust occurrence never happens in the FRP so need of special care for that as such in iron materials, they are non-conductive so they don't get magnetized as materials and they have good optical and thermal properties too. So they are preferred in various in aerospace, automotive, space research and also for the production of several other industry and also consumer related equipment. In order to overcome this mixture of both natural and synthetic composites are manufactured in which the outer layer of composites is covered with the synthetic such as glass fibers and on the inside chemically treated natural fibers such as bagasse, sisal is used. In this treatment process mercerization technique is used where the fibers are dipped in 5% aqueous NAOH solution for 8 hours then they are washed and dried in broad sunlight. These fibers are cut in to small pieces. These natural fibers composite volume ratio are varied and the best ratio at which the hybrid composites possess higher ratio are determined by mechanical testing methods such as **hardness, tensile, moisture absorption, density, impact test.**

2. OVERVIEW OF COMPOSITE:

Composites, plastics and ceramics are the main material that is being used by the present world. Composites have a more significant advantage because these are made by engineering processes and mainly helpful to reduce the weight and hence to increase the efficiency. Composite material consists of two or more materials in a different phase. In traditional engineering impurities in metal can be represented in different phase and by definition considered as a composite, but are not considered as a composite due to modulus of strength is nearly same as that of pure metal. Oldest known composites were natural composites, wood consist of cellulose fiber in lignin composites, human bone can be considered as a osteons embedded in an interstitial bone matrix.

21 DEFINITION OFCOMPOSITE:

Composites are materials consisting of two or more chemically distinct constituents, on a macro-scale, having a distinct interface separating them. One or more discontinuous phases are embedded in a continuous phase to form a composite. Composite mainly formed from two distinguished materials one of which is in the particle or fiber or in sheet form are combined with other material known as a matrix. Fiber in the composites acts as a principle load carrying member due to its high strength modules while matrix in the composites acts as a load transfer medium between the fibers. Due to more ductility of the composite it gives matrix high toughness.

22 PROBLEM IDENTIFICATION

- Natural fiber composites are poor in mechanical properties compared to synthetic fiber composites because the natural fibers have water absorption property and also bio-degradable properties.
- Poor moisture resistance which causes swelling of fibers failure of structural performance in natural fibers.
- Poor thermal resistance, electrical insulation, and sound insulation in natural fibers.

23 USE OF COMPOSITE:

Due to weight saving advantage composites are mainly used in applications like automobile and aircraft where even a small amount in reduction of weight also count. Some uses of composites are described below:

- In aircraft it is used in the door skin on the stabilizer box fin, in elevators, rudder, loading gear, tail, spoiler, flap body etc. 20-30% reduction in weight is possible by the use of composites.
- In aerospace it uses to make space shuttle, space station where it comprises the function of weight reduction. It is used because it shows low value of co-efficient of thermal expansion.
- In automobile it uses to make body frame, chassis components, engine components, drive shaft, leaf spring, exterior body part etc. and it performs different functions such as due to its high stiffness it has good damage tolerance, good surface finish and appearance, weight reduction hence higher fuel efficiency.
- In sporting goods, it uses to make tennis and racquetball, racquets, golf club shaft, head bicycle frame, skis, canoe helmets, fishing poles tent poles etc. It is used because it helps to design weight reduction vibration damping design and has high flexibility.
- In electrical it used to make printed circuit board, computer housing, insulators, randomness battery plates. And it is used because of portable weight saving.

3. METHOD: [Hand lay-up method]

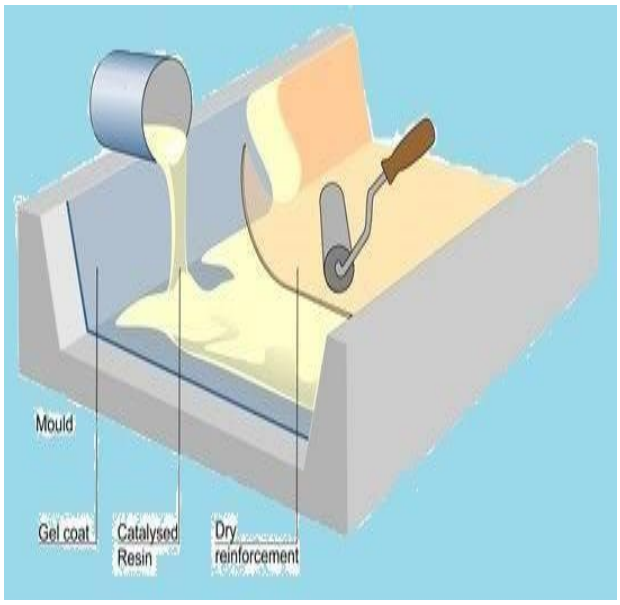

Figure 3.1 hand lay-up method

31 PREPARATION OF HAND LAY-UP METHOD:

- For hand layup process method first the bottom layer is covered by polythene sheet and the PVA (poly vinyl alcohol) are applied on it to avoid the stickiness of the resin with the bottom sheet and also they are applied on the top and on the sun mica sheet.

- The epoxy resin(ly-556) and hardener (hy-951) are mixed in the ratio 10:1 they are stirred well. First the glass fibers are placed on the bottom then the bagasse and again the glass fiber and then the flax fiber is placed and at last the top layer is coveredby glass fiber the resin are poured at each layer of fiber.

- The volume of bagasse and sisal are varied based on the weight ratio then a force is applied constantly to avoid void formation and set to cure for 6 days.

- By repeating the procedure and changing the volume ratio six more composites are prepared.

32 COMPOSITE PREPARATION:

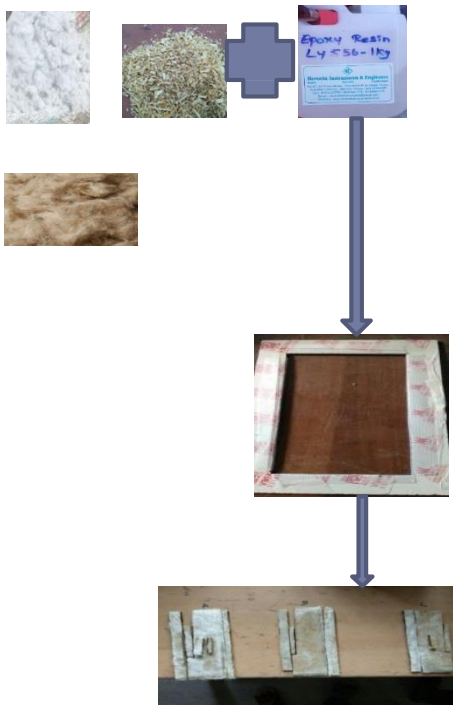

Figure 3.2 composite preparation

4. TESTING:

4.1 **Hardness test**

4.2 **Impact test**

4.3 **Moisture absorption test**

4.4 **Density test**

4.1 Hardness test:

The surface hardness of the material is determined from hardness test. The testing equipment used is of Rockwell hardness where the force of 100 kgf is applied with help of a ball indenter. The intruder intrudes the specimen and mark the impression on the composite material the depth of the specimen is determined. The process is repeated on at different places and the average is taken. The resulting Rockwell number represents the difference in depth from the zero reference position as a result of the application of the major load.

Table 4.1 Hardness test

Speci-men	Weight ratio (%)			Load (kgf)	RHN
	G	B	F		
A	30	10	10	100	50
B	30	8.75	11.25	100	55
C	30	11.25	8.75	100	63
D	30	7.5	12.5	100	30

4.2 Impact test:

In impact test the amount of force that the processed material can withstand are determined by the application of sudden impact load. The amount of energy that are spend to resist the swinging pendulum is noted in the impact testing equipment. Force applied is not a constant force it's a sudden impact load. From the result of the impact test we can determine that specimen C possess higher impact strength this specimen absorbs more energy compared to other specimen.in this specimen the amount of bagasse contents is larger but if we further increased the presence of bagasse in larger volume the impact strength decreases. So at certain weight ratio the strength is greater but when the volume is further increased the strength decreases.

Table 4.2 Impact test

Speci-men	Weight ratio %			Energy absorbed (j)
	G	B	F	
A	30	10	10	70
B	30	8.75	11.25	48
C	30	11.25	8.75	46
D	30	7.5	12.5	40

4.3 Moisture absorption test:

In moisture absorption test the amount of percentage of water absorbed at certain pressure. And increase in weight of the composites at particular intervals. This weight ratio is increased mainly due to two major reason one is the presence of voids and the other is the characteristics of the fiber. And also if the water settles on the voids the material losses it's mechanical characteristics strength. From the graph it is noted that on whatever precautions were taken to reduce the moisture absorption content the specimen material due to its natural characteristics or the manufacturing process that lead to formation of voids. From the graph it's noted that specimen C possess higher water absorption characteristics.

Table 4.3 Moisture absorption test

Speci-men	Weight (grams)					
	0 hr	1 hr	2 hr	3 hr	4 hr	5 hr
A	4	3	5	5	3	4
B	5	5	6	6	5	5
C	6	7	8	6	6	7
D	6	7	8	7	6	7

4.4 Density test:

In Density test voids of the specimen are determined from the comparison of obtained density and expected density. The voids are formed by several factors such as not applying the adequate force, poor interface bonding, formation of air holes so on. This density comparison is determined by calculating the weight of the composite using weight gauge and the theoretical density values are obtained from the equation.

$$\rho = \frac{1}{w_g/\rho_g + w_b/\rho_b + w_f/\rho_f + w_m/\rho_m}$$

Wand p is the weight fraction and density respectively. And suffix g, b, f, m represents the luffa, ground nut, almond, matrix. From the density test results as shown in the table concluded that even though certain procedure is hardly undertaken to reduce the formation of voids in the composites at certain circumstances there is the formation of voids on the composites because the valuated practical density is less than the calculated theoretical

Table 4.4 Density test

Speci-men	Theoretical [kg/cm^3]	Experimental [kg/cm^3]
A	0.48	0.69
B	0.88	1.12
C	0.63	0.89
D	1.01	1.24

5. CONCLUSION:

Glass fiber has greater mechanical strength. Hence agricultural products such as bagasse and flax are introduced in to it. And the variation in the characteristics of the composites are studied and found that. At certain introduction in the volume ratio of the bagasse and flax the strength of the composites is greater. In those volume ratios the content of bagasse is lesser and the presence of flax is higher. But at test such as impact were the specimen is subjected to sudden load we determine that increase in bagasse content store more energy and resist breakage than the specimen that possess increase in flax content. From the obtained different test results we determined that increase in flax content make the composite have good elongation characteristics. And increase in volume of bagasse specimen possess good force absorption characteristics.

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