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Experimental Investigations on Mechanical Properties Of Jute Fiber Reinforced Composites with Polyester and Epoxy Resin Matrices

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Abstract

The composite manufacturing has been a wide area of research and it is the preferred choice due to its superior properties like low density, stiffness, light weight and possesses better mechanical properties. This has found its wide applications in aerospace, automotive, marine and sporting industries. There has been continuous lookout for synthesizing composites without compromising on the mechanical and physical properties. In this research, fiber reinforced composites were prepared with jute fibers of fiber length 5-6 mm. The resins used in this study are polyester and epoxy. The composites were synthesized at 18:82 fiber-resin weight percentages. The prepared composites were tested to study the mechanical properties of the composite such as tensile strength, flexural strength, impact strength and hardness. The results show that the jute reinforced epoxy composite exhibited better mechanical properties than Jute-polyester composite.

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Keywords: Jute fibers, polyester, epoxy, composites.

1. Introduction

Focus on the development of natural fibers like jute, coir, sisal, pineapple, ramie, bamboo, banana etc., is to explore its application in low load condition. Composites, the wonder material with light-weight, high strength-to-weight ratio and stiffness properties have come a long way in replacing the conventional materials like metals, woods etc. The replacement of steel with composites can save a 60-80 percentage of component weight and 20-50 weight percentages with the aluminium components. The polymer based composite materials use is increasing

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because of their light weight, good mechanical and tribological responses [1]. However, composites encounter problems such as fiber fracture, matrix cracking and delamination. Of these, fiber fracture and matrix cracking plays an important role in laminates under tensile load [2-5].

After the composite development to meet the challenges of aerospace sector, researchers have focused to cater to needs of domestic and industrial applications. The abundant availability of natural fibers such as jute, coir, sisal, pineapple, ramie, bamboo, banana etc., has given a impetus to the development of natural fiber composites. This development is done considering the deforestation (depletion of forest resources) with an objective of returns for the cultivation of natural fibers. Composite boards have been used in development of panel and flush doors to satisfy the low cost housing needs. Other product development such as panel roofing sheets with sisal fibers and glass added to jute fiber produces large increase in mechanical properties of composites. Since natural fiber composite being cost-effective materials finds it application in building, construction industry (panels, false ceilings, partition boards etc.), packaging, automobile & railway coach interiors and storage devices.

Recent research [6,7] indicates that natural fibers can very well be used as reinforcement replacing the expensive glass fibers in polymer composites. Plywood, medium density fiber boards, panel and plush doors were developed from Jute and coir based composites. The addition of jute fiber (12–24 volume %) in glass showed an increase in mechanical properties of the composites. Hence thus jute fiber shows an effective and value added application. The applications of jute polyester composites in use are lampshades, suitcases, paperweights, helmets, shower, bath units, electrical appliances, covers, pipes, post-boxes, roof tiles, grain storage silos, panels for partition and false ceilings, bio-gas containers, and in the construction of low cost mobile as well as pre-fabricated buildings for use in times of natural calamities. The study of natural fiber reinforcement is due its abundant availability in wide variety [8-15].The material scientists all over the world focused their attention on natural composites reinforced with jute, coir, sisal, pineapple, ramie, bamboo, banana primarily to cut down the cost of raw materials is to explore its application in low load condition.

The composites can be prepared with desired properties by orienting the fibers according to the application. The composites are comparatively cheaper to manufacture and there are various manufacturing processes available for the composites. The surface finish of the composite is comparatively much higher and it can be manufactured in different techniques. The use of composites has given more flexibility to design engineers to develop new design and for modifications in the existing design. Since the composites are easier to handle and synthesize.

The fabrication of composite by using short jute fiber of length 2 - 3 mm with polypropylene as resin was carried out. The composites were prepared considering fiber by weight 20% and resin by weight 80% using compression molding. The mechanical properties were evaluated such as flexural strength, tensile strength, impact strength, and tensile modulus, elongation at break, flexural modulus and hardness of the composites [16]. The significant reduction in flexural strength is due to the impact induced damage and that the residual flexural strength is more susceptible to damage than residual flexural modulus. A number of studies are available on the impact behaviour of unidirectional laminated composites [17].

The mechanical properties of jute reinforced polyester composite by bleached and control jute composite at various fiber loading was evaluated. Composite 60% fiber loading showed highest tensile strength (90.52±8.83). The highest tensile strength was observed for control jute polyester composite (JPH(C)) whereas bleached jute polyester (JPH (B)) composite showed highest flexural strength. Composite made from bleached fiber showed higher flexural properties due to the increase in the extent of chemisorption of bleached jute fiber surface [18]. Though there are some studies on the impact behaviour of woven fabric composites [19], further studies are necessary for their effective use in structural applications. Due to its easy availability, low cost, high strength (tensile strength), makes it a suitable material for reinforcement in composite. It has higher strength and modulus compared to plastic [20] and it is a good replacement for conventional fibers in many conditions. The jute fibers have a uniform cross section with microfibrils having a multicellular structure. However, its physical and mechanical properties are highly inconsistent and mainly depend on geographic origin, climatic growth conditions and processing techniques. The study of the mechanical properties of PALF(Pine Apple leaf fiber)/glass and sisal/glass fiber reinforced polyester composites reported small amounts of glass fibers were incorporated into the PALF(Pineapple leaf fiber). The sisal reinforced polyester composites and was found to have an improvement in its flexural, tensile and impact properties, thereby showing a positive hybrid effect [21].

The improvement in the jute vinlyl ester composite by treating jute fiber with NaOH (5%) solution for 0, 2, 4, 6 and 8 hours at 30ºC was evaluated. jute fiber reinforced at 35 weight percentage and treated for 4 hours showed an improvement in the flexural strength by 20%, for the flexural modulus 23%, and 18 % for the laminar shear strength [22].

The effect of 50 % fiber loading of (control and Bleached) jute fiber reinforced epoxy composite was reported. The mechanical properties of bleached composite showed better flexural and impact strength and higher tensile strength was observed in controlled jute epoxy composite. The fiber de-lignified and de-waxed and cell separated with each other and surface becomes clean with increased micro roughness which enhances the fiber matrix mechanical interlocking in bleached jute. The effect of coupling agent between fiber and matrix was studied. The observations reported the enhancement in mechanical performance. The tensile strength (131MPa) and tensile modulus (2.35GPa) of 50% fiber loaded bleached jute reinforced epoxy composite is lesser than the corresponding 148 MPa and 3.18GPa of unbleached jute epoxy composite [23].

On the contrary, flexural strength (155MPa) and flexural modulus (14.232GPa) of raw jute epoxy composite is lesser than the corresponding 196MPa and 20.4GPa of bleached jute reinforced composite. Impact strength of bleached jute epoxy composite (107.94 J/K) is higher than the control jute epoxy composite (94.46 J/K). The effect of chemical modification on the impact energy of jute/Flax/hemp epoxy composite was studied and concluded that the modified surfaces enhanced good bonding which resulted in increased impact strength. The dispersion of aliphatic silane and aromatic silane with epoxy, showed better with aliphatic silane. The transverse bending strength and transverse tensile strength increased for NaOH treated jute/epoxy composites. The decrease in water uptake with fiber surface treatments and the diffusivity of the composites compared to the untreated state [24].

Due to the immense scope in the field of composites the need to find an alternative to the glass fiber reinforced composites is imminent due to its non-biodegrading property. Development of a high performance composite using natural fibers has been a major area of concern. This research is focused on considering jute fiber of length 5-6 mm to study and compare the improvement in the mechanical properties of natural fiber reinforced composite for two different resins (thermosetting polymers). The natural fiber reinforced composites were synthesized by using jute reinforced with polyester, and epoxy resins were developed. The microstructures of the fiber reinforced composites were observed in scanning electron microscope composites. The prepared composites were subjected to mechanical characterization such as hardness, flexural strength, impact, tensile test and the mechanical properties were evaluated and analysed.

Nomenclature

σ_t	= Tensile strength.
P	= Ultimate load on the specimen.
b	= Initial width of the specimen.
h	= Initial thickness of the specimen.
E	= Young's Modulus.
σ_f	= Flexural strength.
L	= span length of the specimen.
b	= width of the specimen.
h	= thickness of the specimen.
S	= measured deflection.
TETA	= Triethylene tetra amine.
MEKPO	= Methyl Ethyl ketone peroxide.

2. Experimental Procedure.

Mainly two types of jute is available in the market white jute or capsularis and olitorious jute fibers. The capsularis jute is whitish in nature and the olitorious comes in yellow, grey, brown varieties. The jute used for this research is olitorious jute and it was grey in colour. The jute fiber treated with NaOH was mixed with different resins epoxy and polyester. The fiber resin weight percentage was taken as 18:82. The jute fibers were chemically treated with NaOH solution. The jute fiber was immersed in NaOH solution for 24 hours and then taken out and dried in sunlight. Figure 2 shows the synthesis of jute-epoxy and jute-polyester composite with appropriate weight in grams.

The hardener used for epoxy resin was triethylene tetramine (TETA) and for the polyester was methyl ethyl ketone peroxide (MEKPO). The fibers were added to the resin mixed hardener with required weight percentages. The fiber resin hardener mixture was poured in to the moulds for different testing prepared as per ASTM standards. The setting time taken by the composites was approximately 24 hours. The prepared composites were subjected to hardness, tensile, flexural and impact tests. Hardness was measured with Rockwell hardness tester as per ASTM D785 standard. The synthesis of composites includes two composites of jute with polyester and epoxy, and the characterization includes the testing of the composites is shown in figure 1. The specimen prepared for the tensile test is according to the ASTM D3039 standards. Figure 3 (a) and (b) shows Universal Testing Machine (Shimadzu) on which the tensile and three point bending tests were carried out on the composites. The tensile test was measured from the universal testing machine (Shimadzu). The specimen was held on the machine and tensile force was applied. The displacement was measured and the force Vs displacement graphs were plotted.

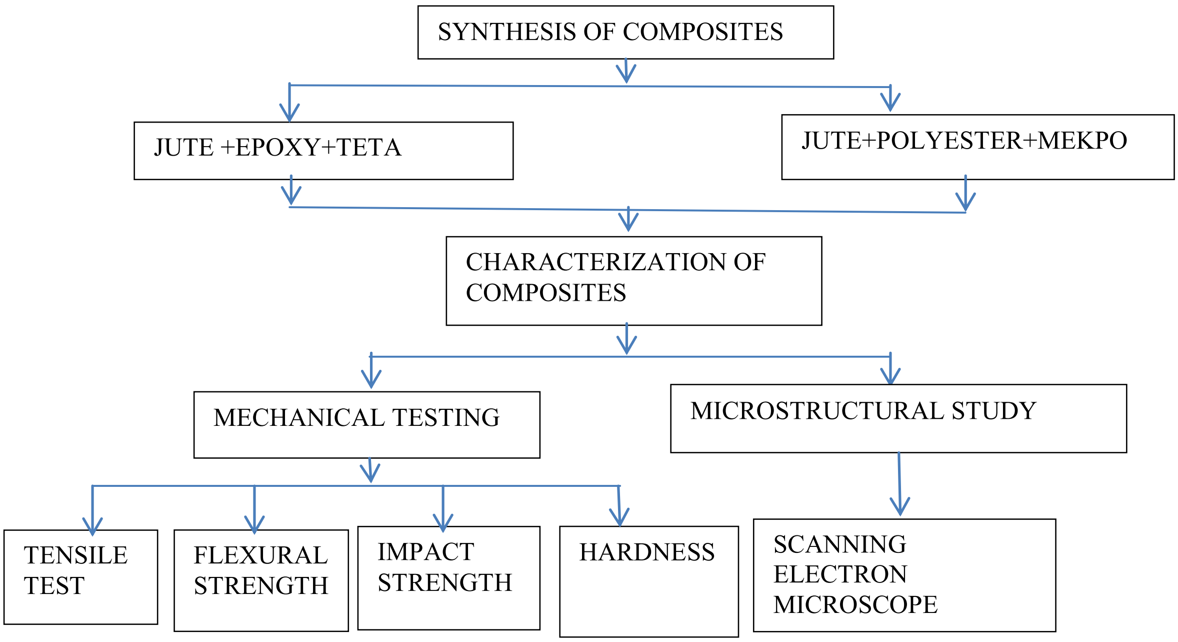

Figure 1. Research methodology

The flexural test was carried out using three point bending test in universal testing machine according to ASTM 790 standard. The impact energy was found by Charpy test. The Charpy test was done to determine the resistance of the jute fiber reinforced composite material against shocks. The test is done by breaking the material in one blow from a swinging pendulum. A test piece of 55 x 10 x 10 mm dimensions in ASTM A370 was notched in the middle at 45° and supported at each end. The energy absorbed was determined in joules. This absorbed energy shows the impact strength of the material. The hammer fractured the test piece and the absorbed energy (in Joule) indicates the resistance of the material to shock loads.

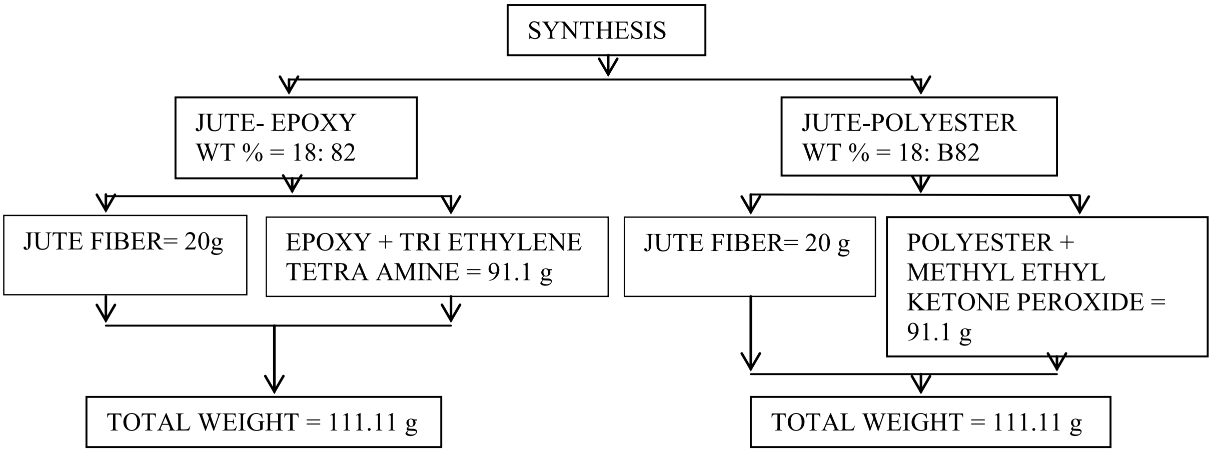

Figure 2. Synthesis of jute fiber reinforced composites in terms of weight percentage.

Figure 3. (a) Universal testing machine; (b) Flexural test setup
(Courtesy : Strength of materials lab, VIT University, Chennai)

3. Results and discussion.

The short chopped jute fiber reinforced epoxy and polyester composites were subjected to mechanical characterization. Its mechanical properties studied are analyzed and compared. The results revealed that the jute-epoxy exhibited better mechanical properties. The jute contains a fairly high proportion of stiff natural cellulose amongst the other lingo cellulosic fibers. The mechanical properties of jute fibers tend to be controlled by the cellulose content and micro fibril angle based on the morphology and fiber composition. The processing time required for jute-polyester composite is comparatively lesser time than jute-epoxy.

3.1. Tensile test.

Figure 4 shows the tensile strength variation for 5% NaOH treated and 10% NaOH treated jute reinforced composites. The tensile test results showed a variation in the tensile strength of the 5 % NaOH treated and 10 % NaOH treated jute fiber reinforced composites. The 5% NaOH treated jute fiber reinforced composites showed better tensile strength (12.46 N/mm^2) than the 10 % NaOH (10.5 N/mm^2) treated jute fiber reinforced epoxy composites. For jute polyester composites it varied from 9.24 N/mm^2 for 5 % NaOH to 7.92 N/mm^2 for 10 % NaOH treated jute fiber reinforced composites. Tensile test was carried out in UTM (Universal Testing Machine) to estimate the tensile strength of jute-epoxy and jute-polyester composite as per ASTM D3039 standards. As from the results it was visible that the 5% NaOH treated jute fiber reinforced composites showed better results than its counterpart the stress strain curves showed in figure are for the 5% NaOH treated jute fiber reinforced composites. The tensile test results show that the maximum force applied was 748 N and 554 N for the jute-epoxy and jute-polyester composites respectively and after which the specimen failed. The maximum displacement yielded by the material was between 1.17 mm and 1.14 mm for jute-epoxy and jute polyester composites respectively. The 5% NaOH treated jute fiber reinforced composites seemed to have a higher tensile strength than 10% NaOH treated fiber reinforced epoxy composite by 18.67 % and for polyester composites it was found out to be an increase of 16.67 %.

The ultimate strength is found using this information and thus the tensile strength was determined. The tensile strength is estimated by using the formula

$\sigma_t = P/bh$ (1)

Where,

P= Ultimate load on the specimen.

b= Initial width of the specimen.

h= Initial thickness of the specimen.

σ_t = 748/(12 x 5)= 12.46 N/mm^2 for Jute epoxy composite.

σ_t = 554/(12 x 5)= 09.24 N/mm^2 for jute polyester composite

Young's modulus = tensile stress / Tensile strain (2)

E = 12.46 / .0117 = 1.064 GPa for Jute epoxy composite.

E = 09.24 / .0114 = 0.811 GPa for jute polyester composite.

The maximum stress obtained from the plot was 12.46 N/mm^2 and strain recorded was 1.17 for the jute epoxy composite, whereas for jute polyester composite, it was 9.23 N/mm^2 and 1.14. The tensile strength of jute epoxy composite was found out to be 12.46 N/mm^2 and 9.23N/mm^2 for jute polyester. The tensile modulus of jute epoxy composite was found out to be 1.046 GPa and that of jute polyester composite as .811 GPa.

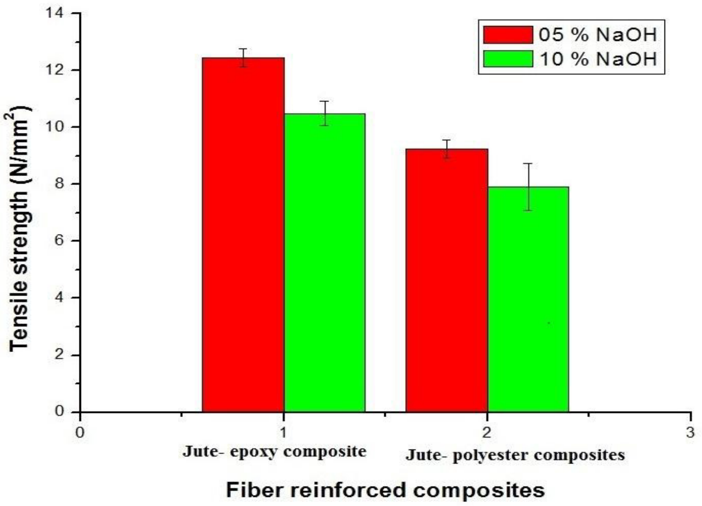

Figure 4. Tensile strength variation for 5% NaOH treated and 10% NaOH treated jute reinforced composites

Under the load condition the resin plays a major role, it transfers the stresses across the composites. For the composite to perform well under shear loads the resin element must not only exhibit good mechanical properties but must also have high adhesion to the reinforcement fibre. The results in this work confirm that the jute epoxy composite exhibited better tensile strength than the jute polyester composite. The tensile load for a composite is very much dependent on response of a composite to tensile loads and also is very dependent on the strength properties of the reinforcement fibres, since they are high compared to the resin system on its own. The comparatively lower values for the composites synthesised is due to the non-uniform stress transfer due to the random orientation of the fibers in the matrix. Fiber agglomeration happens in the matrix and the formation of air-gaps also contributes to reducing the properties of the composite.

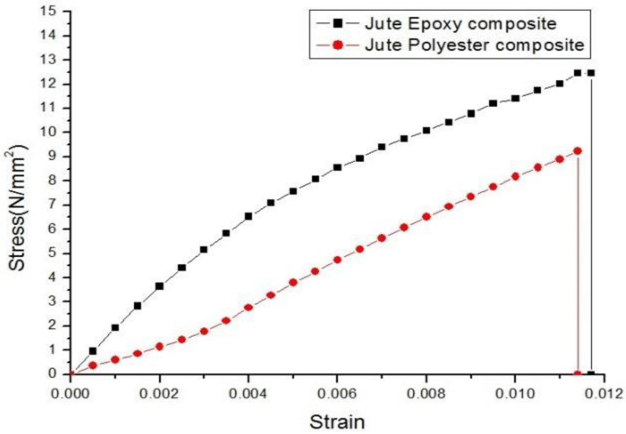

Figure. 5. Tensile test stress - strain curves for 5 % NaOH treated jute reinforced composites

3.2. Flexural Test.

The flexural test or three point bending test was carried out on UTM for the specimens prepared as per the ASTM D790 standard. From the Figure 6 it is evident that 5% NaOH treated jute fiber reinforced polyester composites showed the maximum flexural strength of 44.71 N/mm^2 over 38.6 N/mm^2 showed by 10 % NaOH treated jute reinforced polyester composites. For jute epoxy composites also similar variation was observed as 5% NaOH treated jute fiber reinforced epoxy composites showed better result of 39.08 N/mm^2 than 32.5 N/mm^2 showed by 10 % NaOH treated jute epoxy composites. The maximum force resisted by the jute epoxy composite before failure was 120 N and for jute polyester it was 135 N. The displacements measured were found to be 2.1 and 5.5 mm respectively. The 5% NaOH treated fiber reinforced polyester composites were found to have 15.6 % increase in the flexural strength than the 10 % NaOH treated jute fiber reinforced polyester composites whereas it was 20 percentage for jute-epoxy composites. Flexural strength is determined from the formula given below.

$\sigma_f = 3PL/2bh^2$ (3)

Where,

P= Maximum load (N), L= span length of the specimen.

b= width of the specimen, h= thickness of the specimen.

Span to depth ratio = 13.33.

Flexural strain = $6sh/ L^2$ (4)

S= measured deflection, h = thickness of specimen

L = Length between the supports.

Flexural strain = $6 \times 2.1 \times 6 / 80^2 = 0.012$ for jute epoxy composite

Flexural strain = $6 \times 5.2 \times 6 / 80^2 = 0.029$ for jute polyester composite

Flexural modulus = $L^3m/4bh^3$ (5)

m= initial slope of load deflection curve.

Flexural modulus = 3.08 GPa for jute-epoxy composites.

Flexural modulus = 1.91 GPa for jute-polyester composites.

$\sigma_f = 39.08$ N/mm^2 for 5 % NaOH treated jute-epoxy composites.

$\sigma_f = 38$ N/mm^2 for 10 % NaOH treated jute-epoxy composites.

σ_f = 44.71 N/mm^2 for 5 % NaOH treated jute-polyester composites.
σ_f = 40.5 N/mm^2 for 10 % NaOH treated jute-polyester composites.
The flexural strength of jute epoxy and jute polyester composites computed was found to be 39.08 N/mm^2 and 44.71 N/mm^2.
On observation, the jute polyester composite showed better results than the jute epoxy composite. Flexural modulus indicates stiffness as well as the extent of deformation of a material when it is subjected to the bending stress and gives a measure of the ductility of the material. The ductile materials have a lower flexural modulus as it undergoes a considerable deformation before failure happens.

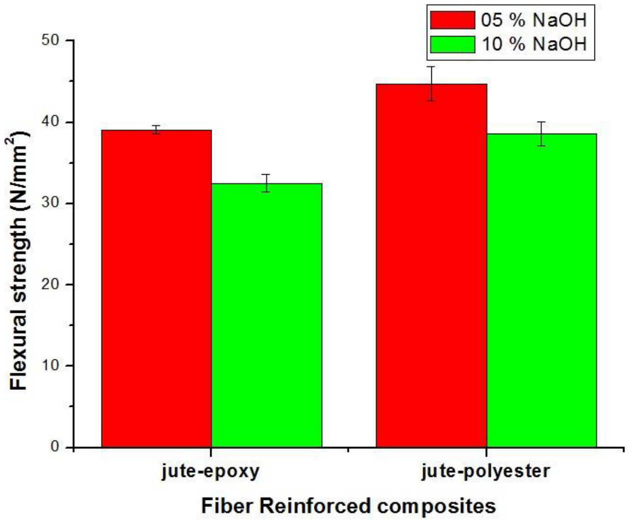

Figure 6. Flexural strength variation for NaOH treated and untreated jute reinforced composites

Whereas the brittle materials have a high value of flexural modulus as it fails before undergoing deformation. Jute epoxy composites have a much higher value of flexural modulus of 3.08 GPa compared to 1.91 GPa of jute polyester composites which indicates higher value of stiffness.

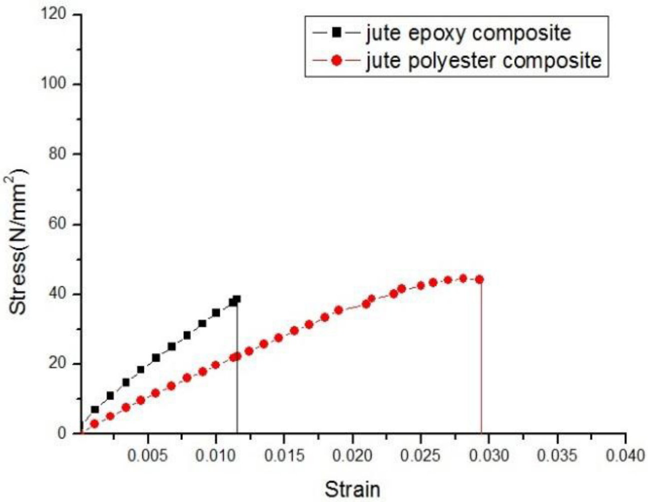

Figure 7. Flexural test stress-strain curves for jute reinforced composites

The stress-strain curves for jute epoxy and jute polyester composites obtained from universal testing machine is shown in Figure 7. Both the composites manufactured were found to be brittle in nature as it underwent a sudden failure. The interpretation shows that the breaking strength and the ultimate strength are the same as it does not show a yield point and even strain hardening have not occurred.

The typical characteristic of the brittle material is to fail while the deformation is elastic and does not show any plastic deformation. The reason for this result could be easily observed by assembling the two broken part surfaces. They form a perfect original component without any traces of neck formation, as like in ductile materials. The jute epoxy showed better tensile and flexural strength than jute polyester composites. Jute epoxy tends to have a higher ultimate strength and strain to failure compared to the other reinforcement impregnated by cross-linking resins which resin. The highest strain to failure, showed a ductile behaviour. However the adhesive and stiffness property of the resin are critical. As the role of, the resin is to maintain the fibres as straight columns and to prevent them from bending. In homogenous materials flexural strength will be same as that of tensile strength of the material but all the materials will have some defects which varies the values obtained. While doing flexural test the fibers at the extreme will experience extreme stress. So if the fibers at the extremes are free from defects then the flexural strength will be higher as those fibers resist the rupture. Whereas in a tensile test equal stress is applied on all fibers as a result of which even the weakest fiber can initiate a crack which will result in the breakage of the specimen. Hence flexural strength is mostly greater than tensile strength.

3.3. Microstructure

Scanning electron microscope images were taken for the samples to observe the microstructure. The images were taken for jute epoxy and jute polyester composites and the images were analysed for better deduction of the reasons for failure and reduction in strength. The 5% NaOH treated composites, fractured during tensile test and impact tests in post fracture condition were subjected to observation under scanning electron microscope.

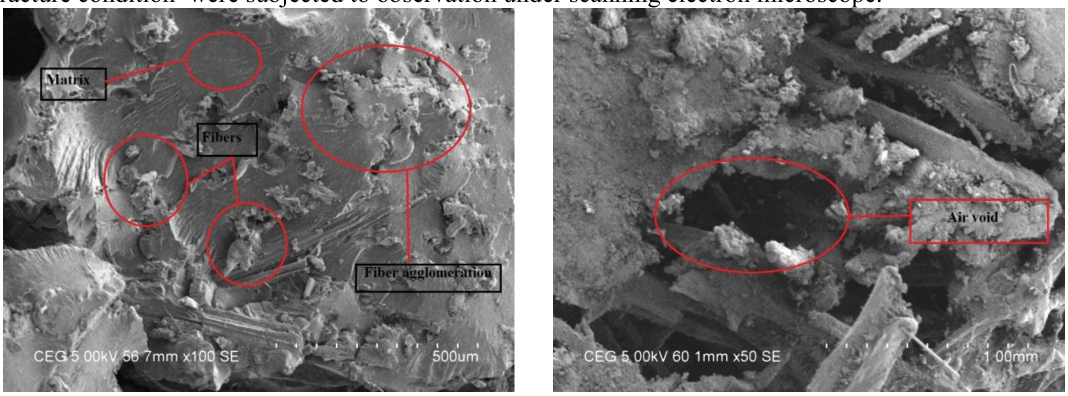

Figure 8. (a)500µm magnification SEM image for jute epoxy composite; (b) 1mm magnification SEM image for jute epoxy composite

The fiber dispersion is clearly visible in the SEM images provided. In the figure 8 (a) at 500µm magnification the fibers are clearly visible in which the fiber agglomeration and matrix without fiber is also visible clearly. In figure 8 (b) the air gaps are clearly visible as indicated in the image. These air gaps reduce the strength of the composite the fiber distribution and orientation are also visible is in the figures 8(a), 8(b), 9(a) and 9(b). The extensive fiber pull-out at the tension side of fracture is visible in the figure 9(b) from which it can be deduced that there is no trace of matrix resin sticking to the fiber which indicates a poor fiber- matrix adhesion as a result of which the composite strength gets reduced by a considerable amount. Figure 9(a) indicates fiber agglomerations as well as fiber pull out.

The lack of adhesion between the pulled out fibers and the resin is also visible from the figure 9(b). The agglomeration is the collective stacking or collection of fibers together in the matrix which reduces the strength by non-uniform stress transfer. The fiber-matrix adhesion, dispersion and orientation of fibers, fiber agglomeration, and presence of air voids these are the influential factors for reduction of strength of the fiber reinforced composite.

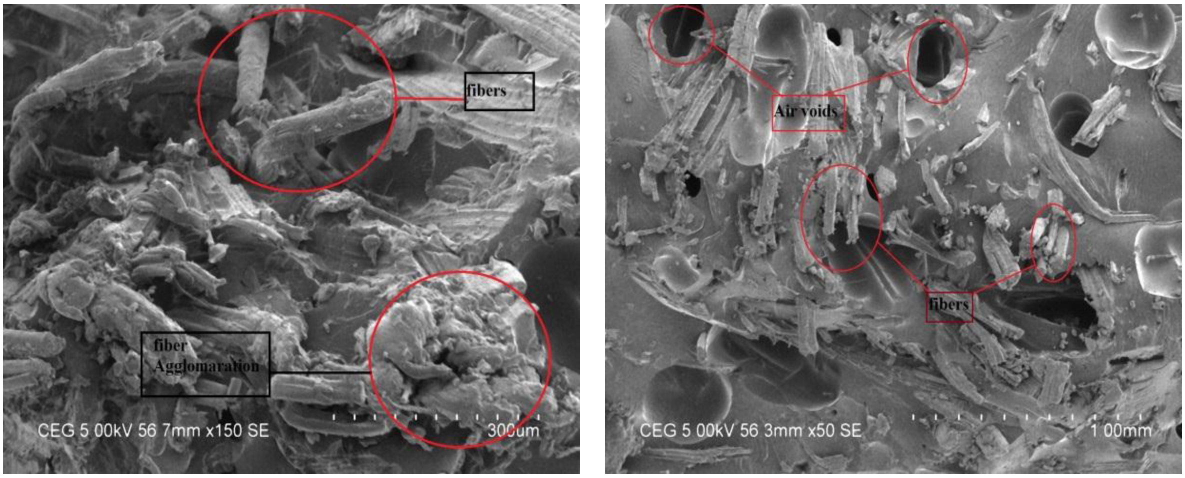

Figure 9. (a) 300 µm magnification SEM image for jute polyester composite; (b) 1 mm magnification SEM image for jute polyester composite

3.4. Impact Test

The charpy test specimens were made according to the dimensions of ASTM A370 in which the dimension is 55 x 10 x 10 mm. One of the main reasons of concern for composites generally is the low values of impact energy. They show relatively low values of impact energy compared to metals. The ways to increase the impact energy of the composites are being made the major area of research. The impact test was carried out by charpy test and the results were recorded are shown in table 1. The tests showed that the composites made with 18:82 fiber resin weight percentage were not very good with the impact stress as it showed very low values form the tests performed. The fiber provides strength for the composite material, as the jute fiber percentage in the composite is only 18 percentage, the jute reinforced composites seems to have low impact strength when compared to the other materials. The Jute-polyester composite seems to have a better impact strength than the jute epoxy. The reason being natural fiber contains higher cellulose content and lower micro fibril angle results in higher work of fracture in impact testing.

Table:1 Summary of results of impact test for jute reinforced composites

Composite	NaOH (%)	Trial no. 1	Trial no. 2	Trial no. 3	Trial no. 4	Average value (J)
Jute- Epoxy	5	2.5	2.5	2.5	3	2.63
Jute- Epoxy	10	2	1.5	2	2.5	2
Jute-polyester	5	3	3.5	3.5	3	3.25
Jute-polyester	10	2.5	2	3	3.5	2.75

Impact strength = (Final charpy scale reading – Initial charpy scale reading) (6)

3.5. Rockwell Hardness

The hardness test is performed with a ball indentor 1/16'' with an applied load of 100 kg is shown in Table II. Rockwell hardness scale chosen was M scale. As M-scale is mostly used to measure the hardness for plastics and soft materials from the hardness values of both the composites, it was found to be almost similar. The results were found to be in close conjunction with each other. In the Rockwell test conducted the hardness value was found to be 44 for jute epoxy and 42 for 5% NaOH treated jute fiber reinforced polyester composites. This shows that the changes in resins have no considerable effect on the hardness of the composite and it mainly depends on the type of fiber used as the reinforcement. The 5% NaOH treated jute fiber reinforced composites showed better results than the 10% NaOH treated jute fiber reinforced composites as the results indicate that 5 % NaOH treated fiber reinforced polyester composites showed 44 HRm whereas 10 % NaOH treated jute fiber reinforced polyester composites showed only 41.67 HRm. Similar was the case with jute reinforced epoxy composites.

Table: 2 Summary of results of hardness test for jute reinforced composites

ROCKWELL HARDNESS (R)	NaOH (%)	TRIAL NO:1	TRIAL NO:2	TRIAL NO:3	AVERAGE VALUE
JUTE-POLYESTER	5	45	39	48	44
JUTE-POLYESTER	10	42	43	40	41.67
JUTE- EPOXY	5	42	48	35	42
JUTE- EPOXY	10	41	45	37	41

4. Conclusion

The jute-epoxy and jute-polyester composite specimens prepared as per ASTM standards subjected to mechanical characterization results were analyzed and compared. The tensile strength for jute-epoxy and jute-polyester composites was found to be 12.46 N/mm2 and 9.23N/mm2. The 5% NaOH treated jute fiber reinforced composites seemed to have a higher tensile strength than 10% NaOH treated fiber reinforced epoxy composite by 18.67 % and for polyester composites it was found out to be an increase of 16.67 %. The tensile modulus of jute epoxy composite was found out to be 1.046 GPa and that of jute polyester composite as .811 GPa. The flexural strength of jute-epoxy and jute-polyester composites was estimated to be 38.68 and 44.71 N/mm2 respectively. The 5% NaOH treated fiber reinforced polyester composites were found to have 15.6 % increase in the flexural strength than the 10 % NaOH treated jute fiber reinforced polyester composites whereas it was 20 percentage for jute-epoxy composites. The jute-polyester composite seemed to have better impact energy than jute-epoxy composites. The 5% NaOH treated jute fiber reinforced composites seemed to show much better results than the 10 % NaOH treated jute composites. The hardness values of both specimens were found to be nearly same. From the above results, it revealed that the jute-epoxy exhibited better tensile and flexural properties. The processing time required for the jute polyester composite is very less compared to jute-epoxy composite. The results of this research indicate better mechanical properties for jute-epoxy, which makes it better suited for the automotive applications rather than jute-polyester composites. Though the composites have some merits and demerits, the combination of the useful properties of two different materials, quicker processing time, lower manufacturing cost, etc., make them as a versatile material in the field of engineering and technology. Hence with this conclusion, it is sure that the technology shows composite is the most wanted material in the recent trend.

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