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Characterization of Epoxy based Natural Fiber Sandwich Composite

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Abstract

Natural fibers have the advantage that they are renewable resources and bio- degradable. These agricultural wastes can be used to prepare fiber reinforced polymer composites for commercial use. Application of composite materials to structures has presented the need for the engineering analysis the present work focuses on the fabrication of polymer matrix sandwich composites by using natural fibers kenaf and jute which are abundant nature in desired shape by the help of various structures of patterns. Here E-glass fibers are used to improve strength. This sandwich composite are Fabricated by simple Hand layup technique. In this composite produce more tensile strength than other composite materials like as banana, sisal, coir, etc.,, The mechanical properties (flexural strength, Tensile strength, impact, and compression) are determined by flexural test, tensile test, impact test, density test, and their results are measured on sections of the material and make use of the natural fiber reinforced polymer sandwich composite material for automotive seat shell manufacturing, marine like boat, ships panels and aero vehicles parts.
Keywords: flexural test, impact test, jute, kenaf and tensile test

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I. Introduction

This chapter includes a survey of the past research already available involving the issues of interest. It presents the research works on the Natural fiber and E- Glass fiber composites and the effect of various Mechanical Parameters on the performance of composites studied by various investigators. The literature review is done based in the following points.

M. sakthivel, mechanical properties of natural fiber (banana, coir, sisal) polymer composites. More currently they have been employed in combination with plastics. Many types of natural fibers have been investigated for use in plastics including flax, hemp, jute, sisal and banana. Application of composite materials to structures has presented the need for the engineering analysis the present work focuses on the fabrication of polymer matrix composites by using natural fibers like coir, banana and sisal which are abundant nature in desired shape by the help of various structures of patterns and calculating its material characteristics(flexural modulus, flexural rigidity, hardness number,% gain of water) by conducting tests like flexural test, hardness test, water absorption test, impact test, density test. The material properties of fabricated natural fiber reinforced composites were observed. It is found that polymer banana reinforced natural composites is the best natural composites among the various combination. It can be used for manufacturing of automotive seat shells among the other natural fiber combinations. [1]

H.raghavendra rao,m. Ashok kumar hybrid composites effect of fibers on mechanical properties. Two different hybrid composites such as treated and untreated bamboo fibers were fabricated and effect of alkali treatment of the bamboo fibers on these properties were studied. It was observed that, impact strength and frictional co-efficient properties of the hybrid composites increase with increase in glass fiber content. These properties found to be higher when alkali treated bamboo fibers were used in the hybrid composites. It is observed that, chemical resistance was significantly increases for all chemicals except carbon tetrachloride. The effect of alkali treatment on the bonding between glass / bamboo composites was also studied. Scanning electron microscope (SEM) were also conducted on the cross sections of fractured surfaces in order to rate the performance hybrid composites were also imparted bear fruits. The hybrid composites of glass/bamboo fiber reinforced epoxy were made in order to evaluate frictional and impact properties, dielectric strength, chemical resistance and SEM analysis studied. The effect of alkali treatment of the bamboo fibers on these properties was studied. The hybrid composites with alkali treated bamboo fibers were found to possess higher impact properties. Treated composites also proved that they have good dielectric properties at 40/0 bamboo/glass fiber weight ratio. These treated hybrid composites were optimized good mechanical properties at glass/bamboo: 40/0. Chemical resistance improved significantly for all the chemicals except for carbon tetrachloride. The elimination of amorphous weak hemi cellulose components from the bamboo fibers on alkali treatment may be responsible for this behavior. [2]

Dr. p v Senthiil, Studies on material and mechanical properties of natural fiber reinforced composites. (volume 3). Many types of natural fibers have been investigated for use in plastics including Flax, hemp, jute, straw, wood fiber, rice husks, wheat, barley, oats, rye, cane (sugar and bamboo), grass reeds, kenaf, ramie, oil palm empty fruit bunch, sisal, coir, water hyacinth, pennywort, kapok, paper-mulberry, banana fiber, pineapple leaf fiber and papyrus. Application of composite materials to structures has presented the need for engineering analysis, the present work focuses on the fabrication of polymer matrix composites by using natural fibers like jute, coir, and hay which are abundant in nature in desired shapes by the help of various structures of patterns and calculating the material characteristics (flexural modulus, flexural rigidity, hardness number, % gain of water, wear resistance, bonding structure) by conducting tests like flexural test, hardness test, water absorption test, wear test, SEM analysis and their results are measured. The material properties (young's modulus, poison's ratio, percentage gain of water, wear and hardness) of fabricated natural fiber reinforced composites were observed and it is was found that polymer hay reinforced natural composites is the best natural composites for manufacturing of automotive seat shells among the other natural fiber combination of coir and jute. [3]

S. M. Sapuan, Effect of fiber surface modification on properties of kenaf/poly (vinyl alcohol) composite film. Kenaf/poly (vinyl alcohol) (PVA) composite films having 5, 10, 15% wt% of fiber loadings were pre- pared via aqueous mixing. The mixture was casted as composite film and it was characterized. Tensile properties, Fourier transform infra-red (FTIR) and morphology analyses were reported. The effect of fiber surface modification on the properties of composite film was investigated in the study. The result of citric acid modification was much better than the traditional mercerization of fibers via sodium hydroxide solution. The biodegradability of the composite films was evaluated by soil burial test. The soil burial test revealed that the modified Kenaf/PVA composite film was biodegradable in nature environment. It achieved the highest 8.91% reduction after 15 days buried under soil and exposed to environmental condition. Kenaf/poly (vinyl alcohol) (PVA) composite films were prepared by solvent casting method and glycerol was used as plasticizer. A simple route to study the potential uses of Kenaf in biodegradable composite was carried out. Effect of alkaline and citric acid fiber modification was studied in this paper. Composite film prepared from citric acid modified Kenaf/PVA showed a better elongation characteristic. 5 wt% citric acid modified Kenaf/PVA plasticized achieved the highest elongation percentage of 881.42%. However, the overall tensile strength of the composite films decreased after addition of fibers. Weight loss of the film after soil burial test revealed that the chemically modified Kenaf/PVA composite film is biodegradable in nature environmental condition. The basic advantage of this product is its good elongation for packaging purpose and its biodegradability which can ensures a safe disposal of waste plastic to our environment. Further research work such as optimization study on the reaction parameters and types of biodegradable polymer is needed to improve the quality of the composite film. [4]

Vijaya kumar ,tensile behavior of banyan tree fiber reinforced composites. Our work mainly focuses on converting waste material into raw material and to increase the strength of the fiber reinforced polymer composite. The study has been carried out in view of highlighting advantages of natural fibers over synthetic fibers. In this work polyester is used as a matrix and banyan tree fiber is used as a reinforcing material. Tensile test specimen is made as per ASTM D638 I. Material properties of the composite have been studied with the help of different percentage weight ratios of matrix to fiber. Also the strength of composite is estimated with the variation of fiber length. In this paper methodology of conducting the fiber preparation of mold and composite have been presented. There has been a growing interest in utilizing natural fibers as reinforcement in polymer composite for making cost effective construction materials in recent years. Among the various natural fibers, banyan is of particular interest in that its composites have high impact strength besides having moderate tensile & flexural properties. As our work shows that ultimate tensile strength of composite specimen is 10-15% less than the pure polymer but the places where we give less importance to Ultimate tensile strength, banyan tree fiber reinforced composites has better applications like insulation boards, door panels, package trays, automobile interior, air craft interior, ceiling tiles etc. [5]

From the above literature survey we have to study of fibers and how to manufacture like as flat plate with various thickness, film sheet, round shape etc.,. The literature gives what are the ways to test the composite like mechanical test, water absorption test, chemical tests, electrical tests etc.

Keeping in view of the current status of research the following objectives are set in the scope of the present research work.

- Fabrication of a new class of epoxy based sandwich composite with bi- directional jute, kenaf and glass fibers.
- To study the influence of fiber loading and fiber orientation on mechanical behavior of composites with the help of universal testing machine.

II. EXPERIMENTAL WORK

A. Materials and Methods

This Chapter describes the details of processing of the composites and the experimental procedures carried out for their characterization and tests which the composite specimens are subjected to the raw materials used in this work are:

Selection of fiber are Glass fibers, Jute fiber and Kenaf fiber with Resin Epoxy (HY556).

B. Fabrication of Composites:

The fabrications of composite slab are carried out by conventional hand layup technique. The bi-directional jute fiber and Kenaf fiber (Mat form) and the E-glass Chopped fiber are used as reinforcement and epoxy.

Fig. 2.1: E-glass Chopped fiber and woven fibers (Jute / Kenaf)

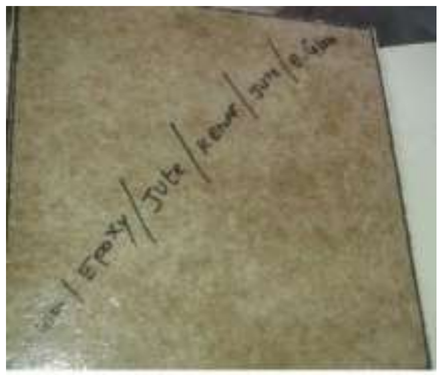

Fig. 2.1: E-glass Chopped fiber and woven fibers (Jute / Kenaf)

III. METHODOLOGY OF WORK

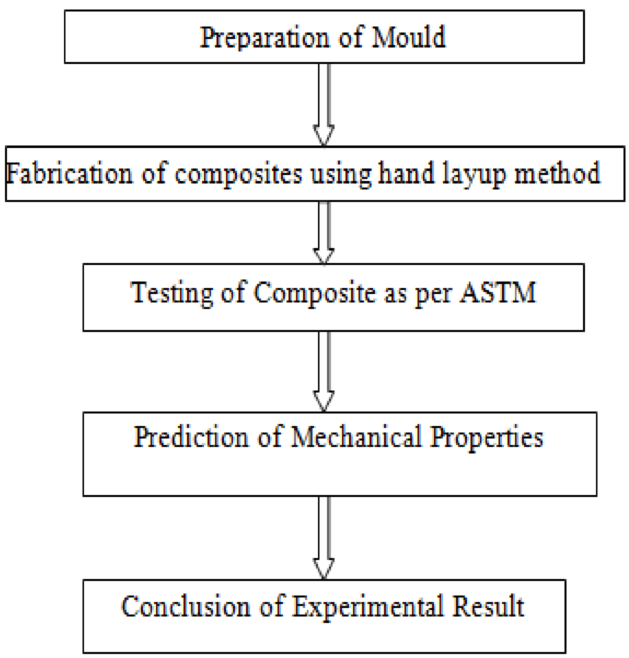

Fig. 3.1: Methodology of work

IV. EXPERIMENTAL RESULTS AND DISCUSSION

A. Tensile Test

The experiments were performed on universal testing machine under axial loading. The laminate were carefully positioned at the center of the cross-head with its end faces exactly perpendicular to the longitudinal axis to get accurate results. The experiments were conducted at a constant crosshead speed 2mm/min. The stress vs strain plots were obtained for each lamina specimen from the automatic computerized chart recorder with the help of software called test Xpert software inbuilt in machine. According to the ASTM D638 maximum ultimate tensile strength value calculated as 62.44Mpa.

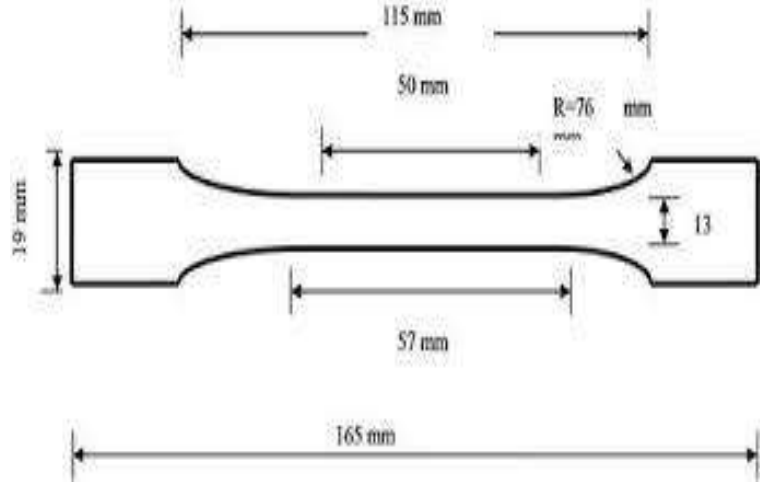

Fig. 4.1: Tensile test specimen (ASTM D 638)

B. *Experimental Value for Tensile Testing*

Table - 4.1
Experimental value for tensile testing

S.NO	STRAIN (No unit)	STRESS in (Mpa)	STRAIN (No unit)	STRESS in (Mpa)
1	0.01	3.5	0.01	3.5
2	0.02	6	0.02	4.1
3	0.03	6.5	0.03	4.58
4	0.04	7	0.04	5.06
5	0.05	8.8	0.05	5.54
6	0.06	12.5	0.06	6.02
7	0.07	16.8	0.07	6.5
8	0.08	18.5	0.08	6.98
9	0.09	22.5	0.09	7.46
10	0.1	26.7	0.1	7.94
11	0.11	34.7	0.11	8.42
12	0.12	42	0.12	42
13	0.13	50	0.13	50
14	0.14	56	0.14	58.906
15	0.15	62.44	0.15	70.82
16	0.16	69.872	0.16	82.734
17	0.17	76.82	0.17	94.648
18	0.18	83.768	0.18	106.562
19	0.19	90.716	0.19	118.476
20	0.2	97.664	0.2	130.39
21	0.21	104.612	0.21	142.304
22	0.22	111.56	0.22	154.218
23	0.23	118.508	0.23	166.132
24	0.24	125.456	0.24	178.046
25	0.25	132.404	0.25	189.96
26	0.26	139.352	0.26	201.874
27	0.27	146.3	0.27	213.788

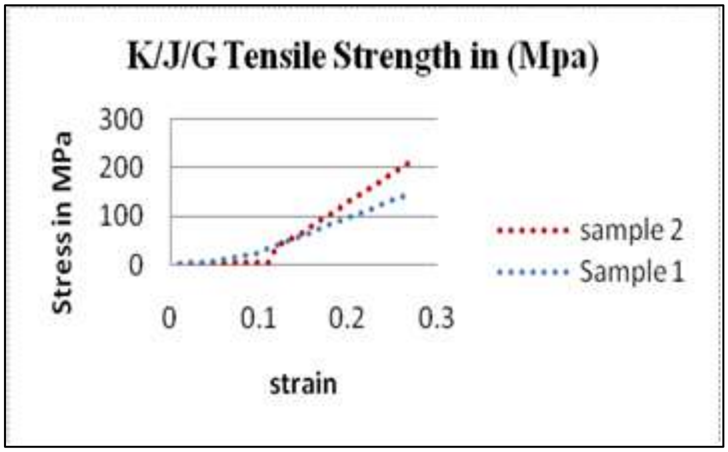

Fig. 4.1: Stress vs Strain graph

Show above the graph, when the stress increases gradually by apply the force and constant area the corresponding strain value is to be increased. When the force 3.21kN attain the sample 2 was increases at that point Maximum stress (213.788Mpa).

C. Flexural Test

Flexural strength is also known as modulus of rupture, bends strength, or fracture strength, which is mechanical parameter of materials. It is defined as a material's ability to resist deformation under bending loads. The transverse bending test is most frequently employed, in which a rod specimen having either a circular or rectangular cross- section is bent until fracture occurs using a three point flexural test technique. The flexural strength represents the highest stress bearing capacity of the material at its moment of rupture. It is measured in terms of stress, which is given by equation for a rectangular sample under a load in a three-point bending test,

Flexural Strength = 3FL/BD2 (Mpa)

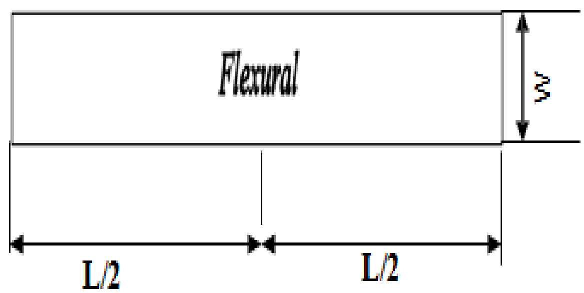

Fig. 4.2: Flexural test specimen (ASTM D 790)

Where,
F, is the load (N) at the fracture point.(0.63KN)
L, is the length of the support span. (100mm)
B, is width of rectangular section. (27.8mm)
D, is thickness of rectangular section. (3.70mm)

D. Experimental Result for Flexural Strength

There, fore the maximum force to be considered as 0.63KN and the Flexural strength can be calculated by the formulae
Flexural Strength = 3FL/BD2 (Mpa)
Flexural Strength = 3 * 0.63X103 / (2 * 27.8 X 3.72)
= 248.3(Mpa)

Table - 4.2
Experimental result for flexural strength

SI.NO	*STRAIN*	*STRESS (Mpa)*	*STRAIN*	*STRESS (Mpa)*
1	*0.01*	*1.4*	*0.01*	*1.4*
2	*0.02*	*0.45*	*0.08*	*0.5*
3	*0.03*	*0.5*	*0.09*	*1.55*
4	*0.04*	*1.55*	*0.14*	*2*

5	0.05	2	0.18	2.6
6	0.06	2.6	0.22	3.35
7	0.07	3.35	0.26	4.2
8	0.08	4	0.3	4
9	0.09	4.6	0.34	4.6
10	0.1	5.4	0.38	5.4
11	0.11	6.3	0.42	6.3
12	0.12	5.9	0.46	5.9
13	0.13	5.5	0.5	5.92
14	0.14	1	0.54	5.98
15	0.15	0.8	0.58	5.99

E. Flexural Strength (Stress Vs Strain Graph)

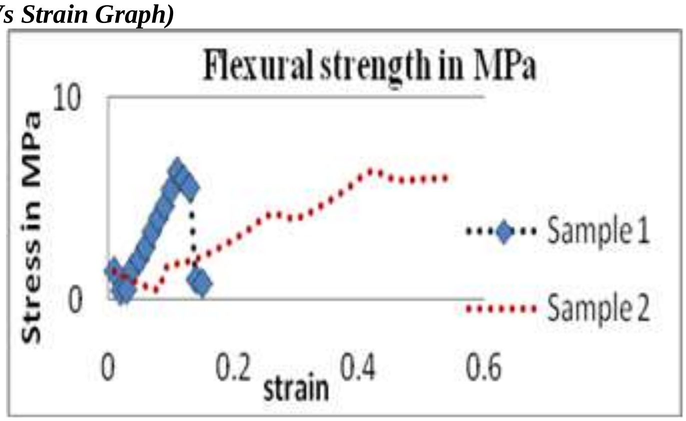

Fig. 4.4: Stress vs Strain graph

From the graph, when the force is applied with the constant area the stress increases gradually by apply the force and corresponding strain value is to be increased. When the force 0.63KN attain the stress and the strain value comes to decreases.

F. Compression Test

The experiments were performed on universal testing machine under axial loading. The laminate were carefully positioned at the center of the cross-head with its end faces exactly perpendicular to the longitudinal axis to get accurate results. The experiments were conducted at a constant crosshead speed 2mm/min. The stress vs strain plots were obtained for each lamina specimen from the automatic computerized chart recorder with the help of software called test Xpert software inbuilt in machine. According to the ASTM D 695 maximum Compression load value is to be calculated as 10.40KN.

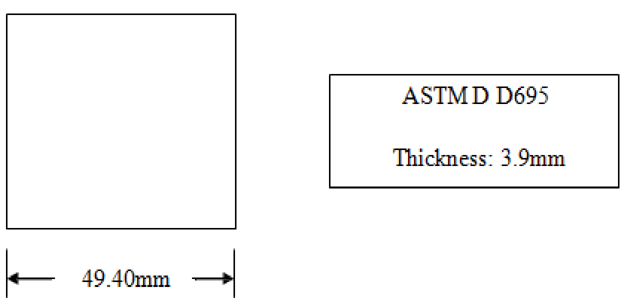

Fig. 4.5: Compression test specimen

G. Experimental Results for Compression Strength

Table - 4.3
Experimental results for compression strength

SI.No	*Sample 1*		*Sample 2*	
	COMPRESSION STRAIN	*COMPRESSION STRESS (Mpa)*	*COMPRESSION STRAIN*	*COMPRESSION STRESS (Mpa)*

1	*0.002*	*2.5*	*0.002*	*2.5*
2	*0.014*	*5*	*0.014*	*5.11*
3	*0.0155*	*10*	*0.0155*	*7.25*
4	*0.021*	*15*	*0.021*	*13.33*
5	*0.023*	*20*	*0.023*	*17.08*
6	*0.026*	*25*	*0.026*	*20.83*
7	*0.028*	*30*	*0.028*	*24.58*
8	*0.03*	*35*	*0.03*	*28.33*
9	*0.032*	*40*	*0.032*	*32.08*
10	*0.034*	*45*	*0.034*	*35.83*
11	*0.036*	*50*	*0.036*	*36.1*
12	*0.038*	*54*	*0.038*	*36.2*
13	*0.041*	*50*	*0.041*	*36.3*
14	*0.043*	*45*	*0.043*	*36.4*
15	*0.0435*	*40*	*0.0435*	*36.5*
16	*0.045*	*35*	*0.045*	*36.6*
17	*0.047*	*30*	*0.047*	*36.7*
18	*0.049*	*25*	*0.049*	*36.8*
19	*0.053*	*20*	*0.053*	*36.9*
20	*0.06*	*15*	*0.06*	*37*
21	*0.063*	*10*	*0.063*	*37.1*

H. Stress Vs Strain

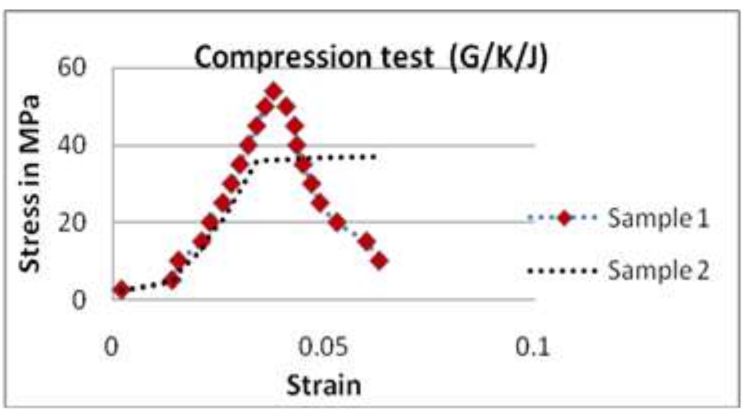

Fig. 4.7: Compression stress vs strain

From the graph, the force is applied on the composite plate the stress and strain values are shown in system. When the force is applied stress increases corresponding strain also increases at 10.40KN attain the composite plate get fully compressed then the corresponding maximum stress value is 54(Mpa) and strain value is 0.038 after the test specimen get break the values comes decreases.

I. Impact Test

The Charpy impact test, also known as the Charpy v-notch test, is a standardized high strain-rate test which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's toughness and acts as a tool to study temperature-dependent brittle-ductile transition. It is widely applied in industry, since it is easy to prepare and conduct and results can be obtained quickly and cheaply. According to the ASTM D 256 impact strength to be calculated 2Joules.

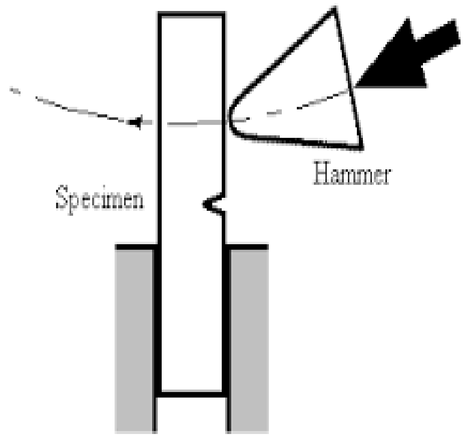

Fig. 4.8: Impact Test specimen (ASTM D 256)

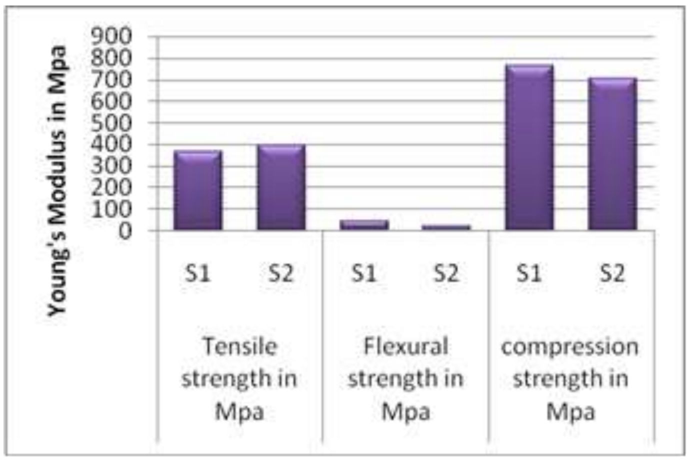

Fig. 4.9: Young's Modulus for Kenaf/Jute/E- Glass/Epoxy

From above, the graph shown that different properties of test were conducted. The maximum young's modulus 763.21Mpa in compression strength compare the tensile and flexural strength

J. Experimental Results

Table - 4.4
Experimental values

ASTM Standards	*Mechanical Properties*	*Kenaf/Jute/ E- Glass/Epoxy*	*Young's Modulus (Mpa)*
D638	*Ultimate Tensile Strength (Mpa)*	*62.44*	*60.458*
D790	*Compression Strength (Mpa)*	*53.98*	
D695	*Flexural Strength (Mpa)*	*283.77*	
D256	*Impact Strength (Joules)*	*2*	
D790	*Fiber orientation (0,90) compression load in KN*	*10.40*	

V. CONCLUSION

The experimental analysis of fiber loading on mechanical properties of jute/glass/kenaf fiber reinforced epoxy based sandwich composites leads to the following conclusions:

The composite was successfully fabricated and tested (tensile 62.44Mpa, flexural strength 283.77Mpa, and compression53.98Mpa.) it has more tensile strength than any other composites materials (banana, sisal, coir etc.,)

There has been a growing interest in utilizing natural fibers as reinforcement in polymer composite for making cost effective construction materials in recent years. Economic and other related factors in many developing countries where natural fibers are abundant demand that scientists and engineers apply appropriate technology to utilize these natural fibers as effectively and economically as possible to produce good quality fiber reinforced polymer composites for domestic and other needs. Among the various natural fibers, kenaf is of particular interest in that its composites have high tensile strength besides having moderate impact & flexural properties.

It is found that polymer reinforced natural fiber sandwich composites is the best natural composites for manufacturing of automotive seat shells among the other natural fiber combination of kenaf, jute and E-glass.

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