Evaluating the Mechanical Properties of Hybried Composites (Kenaf, e-glass, jute)

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Abstract- Composite materials reinforced with synthetic fibers such as glass, carbon, and aramid provide advantages of high stiffness and strength to weight ratio as compared to conventional construction materials, i.e. wood, concrete, and steel. but replace of synthetic fiber of composite material to natural fiber like kenaf,cotton,jute,…etc and improve their properties of natural and compare to other synthetic fiber as well as now used material and prepared for kenaf fiber and e-glass fiber and jute fiber. By conducting the tests as tensile test shear test and water absorption test and find out the best properties of composite materials. And finalize which fiber is having the better properties by comparing the each fiber one to the other. And show that they are used for the real applications.

Keywords: Kenaf, E-glass, jute, Epoxy Resin, hardner.

I. INTRODUCTION

In the past few decades, research and engineering interest has been shifting from monolithic materials to fiber-reinforced polymeric composite materials. These composite materials (notably aramid, carbon and glass fiber reinforced plastics) now dominate the aerospace, leisure, automotive, construction and sporting industries. Glass fibers are the most widely used to reinforce plastics due to their low cost (compared to aramid and carbon) and fairly good mechanical properties. However, these fibers have serious drawbacks. The shortcomings have been highly exploited by proponents of natural fiber composites. Carbon dioxide neutrality of natural fibers is particularly attractive. Attempts have been made to use natural fiber composites in place of glass mostly in non-structural applications. So far a good number of automotive components previously made with glass fiber composites are now being manufactured using environmentally friendly composites.

The interest in natural fiber-reinforced polymer composite materials/Bio composites is rapidly growing both in terms of their industrial applications and fundamental research. They are renewable, cheap, completely or partially recyclable, and biodegradable. Plants such as flax, cotton, hemp, jute, sisal, century, kenaf, pineapple, ramie, bamboo, banana, etc., as well as wood, used from time immemorial as a source of lignocelluloses fibers, are more and more often applied as the reinforcement of composites.

Their availability, renewability, low density, and price as well as satisfactory mechanical properties make them an attractive ecological alternative to glass, carbon and man-made fibers used for the manufacturing of composites.

The natural fiber-containing composites/bio composites are more environmentally friendly, and are used in transportation (automobiles, railway coaches, aerospace), military applications, building and construction industries (ceiling panelling, partition boards), packaging, consumer products, etc.

II. INTRODUCTION TO HYBREID COMPOSITES

2.1. Kenaf is scientifically known as Hibiscus cannabinus. And is closely related to cotton and jute . This is because the crystalline cellulose contentand micro fibril angles of the two fibers are fairly similar. Kenaf is cultivated for its fiber and is well suited in India, Bangladesh, United States of America, Indonesia, Malaysia, South Africa, Vietnam, Thailand, parts of Africa, and in specific parts of southeast Europe. China also has actively developed this plant and is now one of the largest kenaf producers in the world. Recently, kenaf in Malaysia has been identified as one of the potential natural raw fibers to replace tobacco in manufacturing a multitude of products for the construction, automotive, textile and advanced technology sectors.

2.2. Jute is comprised mostly of cellulose plant material AND lignin (a wood derivative). It is thus a lingo-cellulosic

Fiber –partially a textile fiber and partially wood. The fibers are off-white to brown, and 1–4 meters (3–12 feet) long. Bangladesh is the world's largest exporter of jute. Jute is grown in the same land-water area as rice and is a very difficult crop to grow and harvest. Other important jute export countries include India, China, Burma (Myanmar), Pakistan, Nepal and Thailand.

Core uses: twine and rope, sackings, carpets, wrapping fabrics (cotton bale), and the construction fabric manufacturing industry. It can be used in curtains, chair coverings, carpets, area rugs, hessian cloth, and backing for linoleum. Other uses include espadrilles, floor coverings, home textiles, high performance textiles, Geotextiles, and composites.

2.3. E-Glass

E-glass or electrical grade glass was originally developed for standoff insulators for electrical wiring. It was later found to have excellent fibre forming capabilities and is now used almost exclusively as the reinforcing phase in the material commonly known as fibreglass.

III. LITERATURE REVIEW

A brief review of the work carried by various researchers on natural fiber composite on evaluation of various mechanical properties is presented in the following. P.V. Josepha, Marcelo S. Rabellob, L.H.C. Mattosoc, Kuruvilla Josepha, and Sabu Thomas [1]: They described the influence of various ageing conditions like water and UV radiation on the mechanical properties of sisal/PP composites.

Krishnan Jayaraman [2]: His innovative fiber mat production method allowed the fibers to avoid much of the processing degradation. The best possible mechanical properties for the sisal fiber-reinforced polypropylene composites were achieved when the fiber length was greater than 10mm and the fiber mass fraction was in the range 15–35%.

Paul Wambua, Jan Ivens, and Ignaas Verpoest [3]: They have investigated the mechanical properties of sisal, hemp, coir, kenaf and jute reinforced polypropylene composites. The tensile strength and modulus increases with increasing fiber volume fraction. Their study revealed that natural fibers can replace glass in fiber reinforced plastics.

Axel Nechwatal, Klaus-Peter Mieck, and Thomas Reußmann[4]: The manufacturing of long fiber granules is an interesting alternative to known processes such as pultrusionor extrusion. In particular the procedure effective if length-limited staple fibers are used. The long fiber granules made by the new process have a helical fiber arrangement and enable a great fiber length in the composite.

Andrzej K. Bledzki, Omar Faruk [5]: The influence of moisture content on the impact behaviour and the effect of temperature on creep response of the wood fiber reinforced PP composites were investigated in this study. This was also conducted to experimentally determine the effects of the addition of a compatibiliser and wood fiber content on short term creep characteristics of wood fiber-pp composites.

IV. EXPERIMENTAL PROCEDURE

4.1PREPARATION OF LAMINATES

FIBER PREPARATION

METHODS TO PREPARING THE LAMINATES

- *HAND-LAY-UP METHOD*

1. The laminates are prepared by using the **hand –layup- method**.
2. In this method we can use the hand roller and measure bikar, steel rule, glowses, scissors, and also one hacksaw blade is used to cut the laminates with required shape after making the laminate.
3. The quere shape cavity is also used to prepare the laminates .
4. Take the quere shape cavity on a smooth surface, and apply the lubricating oil at the bttom of the cavity,then take the resin and mixed it with hardner with 1:10 and apply the resin in the cavity and in the next step one layer of kenaf fiber is applied on the resin wait 5to 10minutes.and again apply the resin on the fiber again wait 5minutes.
5. This process is continue upto the 9to 10 layers fiber.
6. After preparing the laminates some amount of weight is placed on the laminates i.e. 100kg weight.
7. The weight is placed on that cavity is upto 24hrs.
8. After 24hrs the lamina is chemically reacted with hardner and epoxy then it can be solidified.
9. Repeat the above steps and prepare 5 to 6 samples of laminates.
10. Cut the laminates as per the ASTM standard dimentions then doing tests.

HAND LAYUP OF FABRICATION METHOD

PREPARED LAMINAS

Test specimen e-glass fiber **Test specimen of jute fiber**

SPECIMEN PREPARATION AND TESTING

Testing Methods

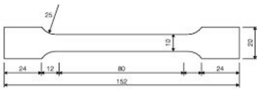
The mechanical testing methods that are carried out were based on American Society for Testing and Materials (ASTM).There are four tests to be perform, Flexural Test(ASTM D790), Water Absorption Test(ASTM D570),Tensile test(ASTM638).

Preparation of Specimens

Specimens for tensile Test and Water Absorption Tests are cut on a jig saw machine as per ASTM standards. The dimensional details each type of specimen is presented in respective diagrams.

Tensile Test Specimen

Specimens for tensile test are cut from Laminates as per ASTM D 790standard.

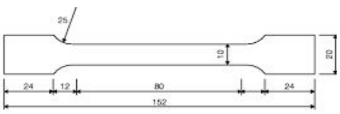


. Tensile Test standard dimensions

COMPOSITE LAMINATE FOR THE TEST SPECIMEN

Water Absorption Test Specimen

Specimens for Water Test are cut from laminas as per ASTM D 570 standards.



Water Absorption Test Standard Dimension

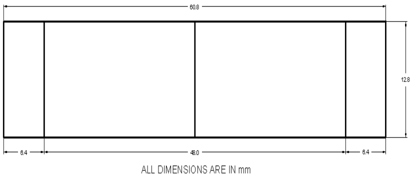
WATER ABSORPTION TEST SPECIMEN TESTING

Tensile Testing

In a broad sense, tensile test is a measurement of the ability of a material to withstand forces that tend to pull it apart and to what extent the material stretches before breaking. The stiffness of a material which represented by tensile modulus can be determined from stress-strain diagram.

Universal Testing Machine (Zwick / Roell Z010 10KN) was used at cross-head speed of 3mm/min. Figure 5.7 shows the Universal Testing Machine (Zwick / Roell Z010). The specimens were positioned vertically in the grips of the testing machine. The grips were then tightened evenly and firmly to prevent any slippage with gauge length kept at 50mm. The precise five tested result were chosen for each fiber loading of *Hibiscus Cannabin us* in general purpose Polypropylene Resin matrix.

Universal testing machine



As the tensile test starts, the specimen elongates; the resistance of the specimen increases and is detected by a load cell. This load value (F) is recorded until a rupture of the specimen occurred. Instrument software provided along with the equipment is recorded the load value (F). Figures Shows the specimens after testing.

Water Absorption Test

This test method covers the determination of the relative rate of absorption of water by fiber when immersed. The moisture content of a fiber is very intimately related to such properties as electrical insulation resistance, dielectric losses, mechanical strength, appearance, and dimensions. In this test the weight of each specimen is taken by Shimadzu Electronic Balance (AY 220) with readability of 0.001g Min, 220g Max. This is supplied by SHIMADZU PHILIPPINES MANUFACTURING INC (spm).

Figure .1 Electronic Balance

Figure .2 Hot air oven.

Short Term (24hr) Immersion

The specimens are placed in oven at 50 ± 3oc for 24 hr to evaporate any water particles in specimen and weight (conditioned) of specimen is noted .The conditioned specimens shall be placed in a container of double distilled water maintained at a temperature of 23 ± 1 o C and shell rest on edge and be entirely immersed. After 24 hr the specimens shall be removed from water, all surface water wiped off with a dry cloth, and weighed immediately, and again the specimens are kept in oven for 24 hours for reconditioning, and weight (reconditioned) of specimen is noted.

$$\textit{Increase in weight}\ (\%) = \frac{\textit{wet weight} - \textit{conditioned weight}}{\textit{conditioned weight}} x100 \quad \ldots\ldots\ldots IV$$

$$\textit{soluble matter lost}(\%) = \frac{\textit{conditioned weight} - \textit{reconditioned weight}}{\textit{reconditioned weight}} x100 \quad \ldots\ldots. V$$

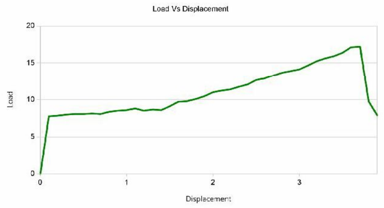
The percentage of water absorbed, which is the sum of the % increase in weight and soluble matter lost.

KENAF FIBER SPECIMEN 1

Orientation of laminate (0/45/90/0)

OBSERVATIONS:

- Length of specimen (L)= 170mmInitial width (bi)= 24mm



- Final width (bf) = 22 mm
- Initial Thickness (ti) = 6mm
- Final Thickness (tf)= 5.5mm
- Initial gauge length (Li)= 90mm
- Final gauge length (Lf)= 95 mm
- Braking load (W) =0.18 KN

Calculations:-

1. Original cross sectional area of specimen (Ao):
   Ao = 48.30 mm^2

2. Final cross sectional area of specimen (Af):
   Af = 42 mm^2

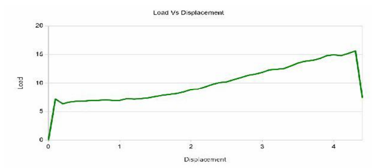
3. Breaking stress = Breaking load / Breaking area
   f = 0.318kN/mm^2

4. Percentage of Elongation = ((Lf-Li)/Li)*100
   dL = 5.55 %

5. Percentage of reduction in area = ((Ai-Af)/Ai)*100
   dA =8.33%

6. Modulus of Elasticity (E) = Stress/Strain = PL/A*dL, E = 1.725*10^5 N/mm^2

JUTE FIBER SPECIMEN



Orientation of laminate (0/45/90/0)
OBSERVATIONS:

- Length of bar (L)= 170mm
- Initial width (bi)= 18mm
- Final width (bf) = 17 mm
- Initial Thickness (ti) = 3 mm
- Final Thickness (tf)= 1 mm
- Initial gauge length (Li)= 80mm
- Final gauge length (Lf)= 85 mm
- Braking load (W) = 7.6 KN

Calculations:-

7. Original cross sectional area of specimen (Ao):

Ao = 90 mm^2

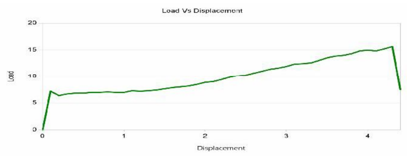
8. Final cross sectional area of specimen (Af):
   Af = 72 mm^2

9. Breaking stress = Breaking load / Breaking area
   f = 0.318kN/mm^2
10. Percentage of Elongation = ((Lf-Li)/Li)*100
   dL =6.25%

11. Percentage of reduction in area = ((Ai-Af)/Ai)*100
   dA =28.57%

12. Modulus of Elasticity (E) = Stress/Strain = PL/A*dL
   E=1.81KN/MM^2

E-GLASS (WOOL) FIBER SPECIMEN



Orientation of laminate (0/45/90/0)

OBSERVATIONS:

- Length of bar (L)= 170mm
- Initial width (bi)= 21 mm
- Final width (bf) = 20 mm
- Initial Thickness (ti) = 2.3 mm
- Final Thickness (tf)= 2mm
- Initial gauge length (Li)= 90mm
- Final gauge length (Lf)= 95 mm
- Braking load (W) = 19.54 KN

Calculations:-

13. Final cross sectional area of specimen (Af):
   Af = 28 mm^2

14. Breaking stress = Breaking load / Breaking area
   f = 0.181N/mm^2

15. Percentage of Elongation = ((Lf-Li)/Li)*100
   dL = 5.31 %

16. Percentage of reduction in area = ((Ai-Af)/Ai)*100
   dA =22.22%

17. Modulus of Elasticity (E) = Stress/Strain = PL/A*dL
   E = 9.71*10^5 N/mm^2
18. Original cross sectional area of specimen (Ao):Ao = mm^2

V. RESULTS AND DISCUSSIONS

Tensile Testing

The results of tensile properties of Hibiscus Cannabinus fiber and E-glass fiber and jute fiber.

Tensile Properties Of Different Types Of Fiber Composite. WATER ABSORPTION TEST TABLE

Type of composite	Specimen	Orientation or laminate coding	Breaking stress KN/MM^2	% of elongation	Ultimate tensile strength KN/MM^2	Modulus of Elastic(E) N/MM^2
Kenaf	1	(0/45/90/0)	0.181	5.55	0.318	1.725×
jute	1	(0/45/90/0)	0.324	8.89	0.324	0.759×
e-glass	1	(0/45/90/0)	0.073	6.25	0.125	8.16×

Type of composite	specimen	Conditional wet	Wet weight	reconditional weight	Increase in weight of specimen	% amount of soluble matter lost
Kenaf	1	45.910	44.150	45.480	3.98	0.94
	2	44.600	43.500	44.250	2.32	0.79
Jute	1	41.140	40.500	40.810	1.56	0.46
	2	31.580	30.45	31.330	1.45	0.41
E-glass	1	36.150	35.051	35.925	3.13	0.50
	2	25.910	24.651	25.308	5.11	1.01

VI. CONCLUSION

From the tensile test the specimen (0/45/90/0)of jute is having more srength compared with the kenaf and e-glass.And from the water absorption test the second specimen of jute is having the best value compared with the other fiber composites.so finally we concluded the fiber jute is having good properties so that we can use this fiber for the real applications like space,structural,automobile.and also this fiber is biodegradable.

Scope For Future Work

This work can be extended in future by using different natural fiber plants and extracting fibers by different procedures. And these prepared laminates are conducting by injection moulding equipment also. And improve the mechanical properties by changing the required resin and fiber combination.And also create the model in ansys.

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