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MECHANICAL PROPERTIES EVALUTION FROM JUTE, CARBON, GLASS, KELVOR HYBRID FIBER REINFORCED COMPOSITES

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Abstract A study on the properties of jute-glass- Kevlar-carbon fibers reinforced composite. The concept of combining different materials to create a new substance with unique features. Using composites have wide variety of advantages like high strength, low specific gravity, improved stiffness, fabrication cheaper etc. The effects of the hybridization, different fibers content and plies stacking sequence on the mechanical properties of the tested hybrid composites were investigated. Results shows improve the tensile, Impact strength and flexure properties of reinforced composite. Impact strength is more in Jute/Carbon/Epoxy laminate composites compare to Jute/Glass/Epoxy, and less compare to Jute/Kevlar/Epoxy. Torque required and withstanding thrust force will be more injute/Carbon/epoxy laminate composites compare to Jute/Glass/Epoxy and less compare to Jute/Kevlar/Epoxy. Jute/Carbon/epoxy laminate having 3mm thickness shows more Rockwell hardness no. compare to Jute/Glass/Epoxy, and less Rockwell hardness no. compare to Jute/Kevlar/Epoxy.

Key Words: Resin, moulding, machinability, indentation, dwell time.

1. INTRODUCTION

The concept of combining different elements to create a new substance with unique features that are not possible with the separate elements is not a recent one. For thousands of years, people have been developing composite materials to make stronger and lighter objects. Early Egyptian and Mesopotamian immigrants employed a mixture of mud and straw to build sturdy, long-lasting structure, which is when composite was first used. Ancient composite goods like ceramics and boats remained to be reinforced with straw.1200AD later.

2. OBJECTIVE AND METHODOLOGY

2.1 Objective

- The primary objective of the present work is to fabricate composite laminates with jute fiber/Glass fiber/Epoxy Resin, Jute fiber/Carbon fiber/Epoxy Resin &Jute fiber /Kevlar fiber/Epoxy Resin of 3mm thickness using simple hand layuptechnique.
- To conduct impact test for jute fiber / glass fiber/ Kevlar fiber /Carbon fiber/Epoxy Resin of 3mm thick as per ASTM-D256 standards.
- To conduct Hardness test for jute fiber / glass fiber/ Kevlar fiber /Carbon fiber/Epoxy Resin of 3mm thick as per ASTM-E18 standards.
- To conduct Machinability test for jute fiber / glass fiber/ Kevlar fiber /Carbon fiber/Epoxy Resin of 3mm thick as per ASTM-D4065 standards.

American Society for Testing and Materials (ASTM)

2.2 Methodology

2.2.1 Materials and experiment procedure:

Reinforcement fiber: Jute fiber 500gsm, E-Glass fiber 200gsm, Carbon fiber 200gsm, Kevlar fiber 200gsm.

Matrix System : Epoxy Resin (Lapox L-12) & Hardener K-6.

Molding Process : Hand lay-up followed by room Temperature molding.

Reinforcements : Matrix ratio 55:45.

Fabrication of the test laminates:

Test laminates of 300 mm X 300 mm were initially fabricated to prepare mechanical test specimens by Hand lay-up followed by Room temperature.

2.2.2 Preparation of the Resin Hardener System:

The resin and hardener were to be mixed in a ratio of 100:10 by weight, as follows:-

1. An empty bowl and brush were taken and weighed.
2. Resin was added to the bowl and the brush setup and was placed on the electronic balance till it registered the constant weight.
3. The hardener was added to the bowl and bowl was removed from the balance.
4. Be resin and hardener were mixed thoroughly using

the brush and is usedimmediately in the preparation of the laminate. From now on this mixture will be referred to as a "resin system".

2.2.3 Preparation of the reinforcing material:

The fabric used was Jute fiber of 500gsm E-glass fiber of 200gsm and Carbon fiberin the form of rolls. The fabric roll is spread on the flat surface and required dimension of 300 min x 300 mm is marked using the marker pen on the fabric spread and cut using a scissor manually. Required such layers of fabric were cut to get the required thickness of laminate in this study.

Raw Materials:

Fig1:Jute fabric 500 gsm

Fig2:E-Glass fabric 200 gsm

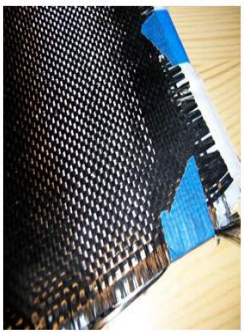


Fig3: Carbon fabric 200 gsm

Fig4:Kelvar fabric 200 gsm

Grams per square meter(gsm)

Table -1: Material Properties

Materials	Density in gm/cc	Volume Fraction (%)	Tensile Strength in MPa	Young's Modulus in GPa	Poisson's ratio
Jute fiber	1.46	0.275	270	76	0.3
Kevlar fibre	1.44	0.275	3620	6	0.35
Glass fibre	2.66	0.275	2000	72	0.21
Carbon fibre	1.8	0.275	4500	228	0.2
Epoxy	1.2	0.45	85	3.4	0.3

Number of fibre layers for each laminates.

Jute/Carbon/Epoxy laminate 3mm thickness = 7 layers

Jute/E-Glass/Epoxy laminate 3mm thickness = 7 layers

Jute/Kevlar/Epoxy laminate 3mm thickness = 7 layers

2.2.4 Layup process for laminate preparation

- The resin and the hardener of required quantities are taken in a previously weighedempty bowl. When they using a paintbrush. The mixture is used immediately in the preparation oldie laminate which otherwise would start gelatin.
- A highly polished flat mold was cleaned and wiped dry wills acetone
- PVA wax was applied and was left for 20 minutes to dry. The wax was then applied to frame a meager acknowledging film.
- A little amount of sap framework was covered on the form surface and afterward a layer of the texture (300 x 300min) currently cut was put on that.
- The sap framework was applied on the texture to wet it and afterward the following layer or texture was put. A similar system was followed till the expected layers were set guaranteeing sufficient impregnation. The Mylar sheet was slicked on the topmost ply and specimen war rolled usingroller. Repeat the same procedure for other two composites.

Fig5: Applying resin over carbon fiber

2.2.5 Post Curing:

Post relieving is a method used to take to the end during the time spent restoring as well as to guarantee the upgrade of the help temperature limits. The post restoring, generally, builds the glass progress temperature (Tg) of the relieved composite overlay. A stage post relieving cycle has been followed as illustrated beneath: The RT-cured specimens were placed in a hot air circulated oven.

1. First specimens were heated to 50°C and maintained at this temperature for 15 minutes

2. Then the ILSS specimens were heated to 70°C for 30 min.

2.2.6 Preparation of specimen as per ASTM standards

- Preparation of Impact specimen as per ASTM-D256 standards for unidirectionallaminates.

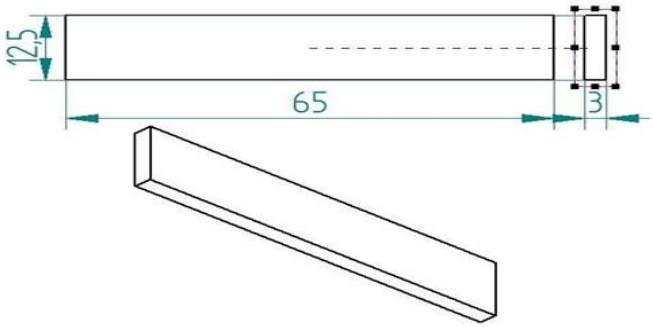


Figure 6. Geometry and Dimension of composite specimen for Impact Test

- Preparation of Hardness specimen as per ASTM-E18 standards for unidirectional laminates.

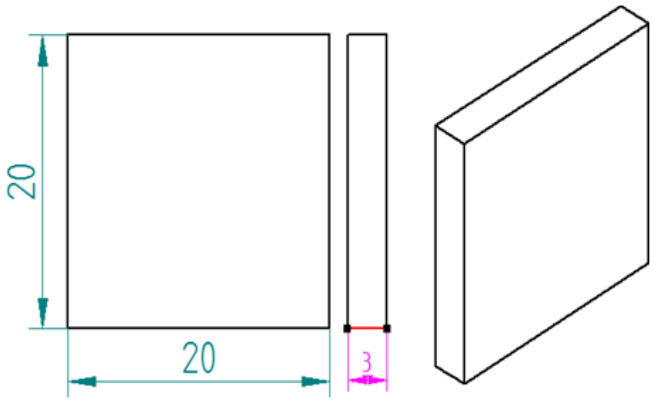


Figure 7. Geometry and Dimension of composite specimen for Hardness Test

- Preparation of Machinability specimen as per ASTM-D4065 standards forunidirectional laminates.

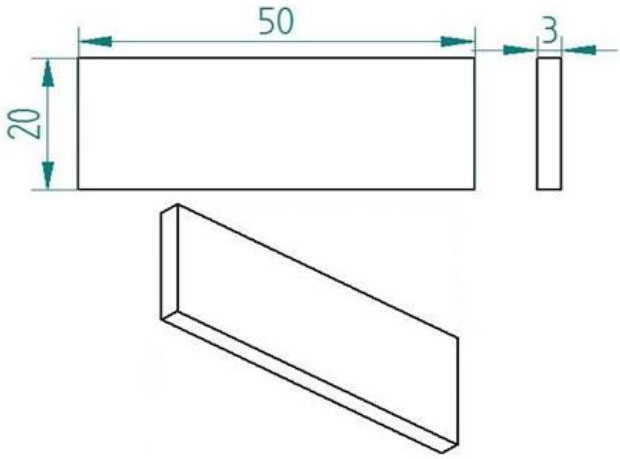


Figure 8. Geometry and Dimension of composite specimen for Machinability Test

2.2.7 Testing of mechanical property

- IMPACT TEST

The steps to be followed to find the Impact strength are

- Place the specimens vertically in the machine fixture fix the weight of R5in the pendulum using Allen keys firmly.
- Set the dimensions of specimen in the 65*12.5*3 mm display type desiredunit of results.
- Lift the pendulum to 150º and lock it and now press the enter button andthe lock releases and hits the specimen.
- Note down the readings in the display and then the same procedure isrepeated for other samples.
- For each material 3 samples been tested and average results are calculated.

- HARDNESS TEST (Rockwell Hardness Tester)

The steps to be followed to find the Hardness are

- Fix the ¼” ball indenter using the Allen key.
- Read the red scale for polymers material for the weight 60kg.
- Lift the anvil that indenter just to touch the specimen inner circle to reachthe 3.
- Now load the specimen and wait for a while that material to absorb the load and now release the load.
- Now note don the reading shown in the indicator of unit RHN.

- MACHINABILITY TEST (Drill Tool dynamometer)

The steps to be followed to find the Machinability are

- Prepare the setup of drill tool dynamometer
- Fix the 8mm drill (HSS) bit in tool holder
- Keeping Feed 6mm/min as constant and vary the speed as the parameter
- Now drill the hole of 8mm of speed 590, 990, 1725 RPM 3 holes I eachmaterial.
- The Torque and Thrust force is display.

Testing Specimens

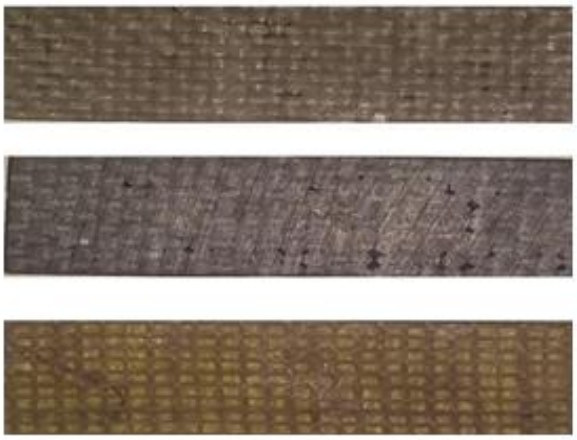


Fig 9: Specimen before test

Jute Glass Epoxy (J/G/E)
Jute Carbon Epoxy (J/C/E)
Jute Kevlar Epoxy (J/K/E)

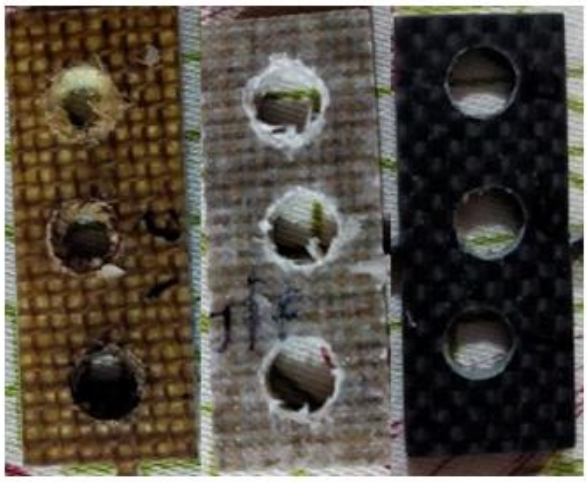


Fig 10: Specimen after test

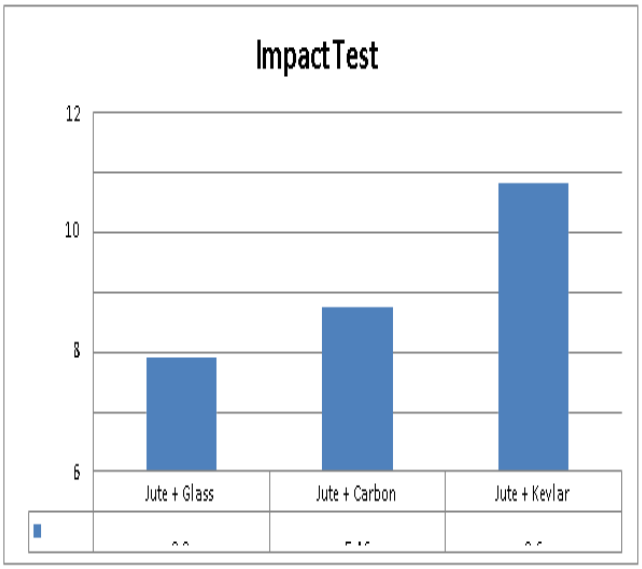
2.2.8 Tabulation and Test Results:

Table 2. Impact Test Results

Sl.no	MATERIAL	TRAIL	READINGS in joules	AVERAGE in joules
1.	Jute/Glass/Epoxy 3mm thick laminate	1 2 3	3.40 4.00 4.00	3.8
2.	Jute/Carbon/Epoxy 3mm thick laminate	1 2 3	5.46 5.40 5.40	5.4
3.	Jute/Kevlar/Epoxy 3mm thick laminate	1 2 3	10.00 9.00 9.80	9.6

From the above table it is clear that Jute/Kevlar/Epoxy laminate having 3mm thickness absorbs more energy than the other two material.

Comparison of Impact test Results of Jute/Glass/Epoxy laminate composites and Jute/Carbon/Epoxy laminate composites and Jute/Kevlar/Epoxy laminate composites (3mm thickness).



From the above graph it is clear that Jute/Kevlar/Epoxy laminate having 3mm thickness absorbs more energy than the other two material.

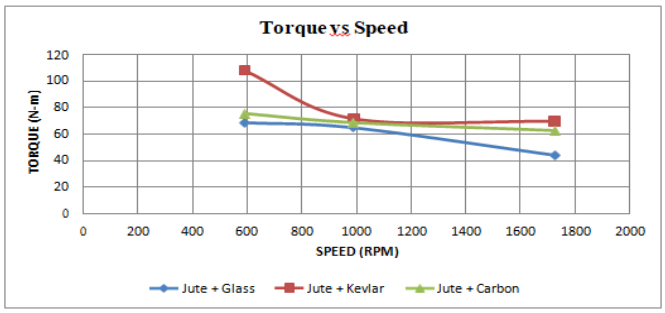
Table 3. Machinability Test Results

Sl.no	MATERIAL	SPEED in rpm					
		590		990		1725	
		Torque N-m	Thrust N	Torque N-m	Thrust N	Torque N-m	Thrust N
1.	Jute/Glass/Epoxy 3mm	68.67	127.48	64.74	147.1	44.14	98.1
2.	Jute/Carbon/Epoxy 3mm thick laminate	75.53	176.52	68.67	156.9	62.74	117.72
3.	Jute/Kevlar/Epoxy 3mm thick laminate	107.91	254.9	71.61	215.74	69.65	166.71

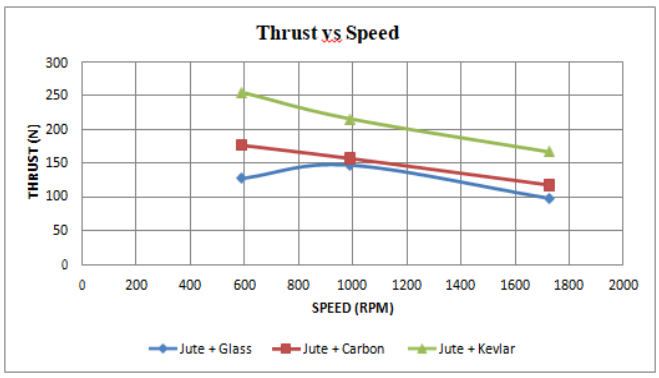
From the above table Torque required and withstanding thrust force will bemore in jute/Kevlar/epoxy laminate composites (3 mm thickness).

Comparison of Machinability test Results of Jute/Glass/Epoxy laminate composites and Jute/Carbon/Epoxy laminate composites and Jute/Kevlar/Epoxy laminate composites (3mm thickness)

- Torque vs Speed



- **Thrust vs Speed**



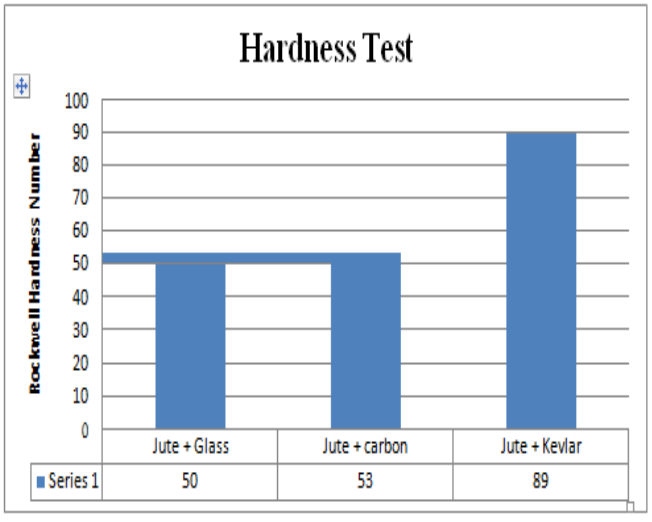
From the above graphs Torque required and withstanding thrust force will be more in jute/Kevlar/epoxy laminate composites (3 mm thickness)

Table 4. Hardness Test Results

Sl.no	Material	Trails	Rockwell Hardness No.	Average in Rockwell Hardness no.
1.	Jute/Glass/Epoxy 3mm thick laminate	1 2 3	57 52 43	50
2.	Jute/Carbon/Epoxy3mm thick laminate	1 2 3	57 59 43	53
3.	Jute/Kevlar/Epoxy 3mm thick laminate	1 2 3	88 92 88	89

From the above table it is clear that Jute/Kevlar/Epoxy laminate having 3mmThickness shows more Rockwell Hardness no. than the other two materials

Comparison of Hardness test Results of Jute/Glass/Epoxy laminate composites and Jute/Carbon/Epoxy laminate composites and Jute/Kevlar/Epoxy laminate composites (3mm thickness)



Above graph it is clear that Jute/Kevlar/Epoxy laminate having 3mm Thickness shows more Rockwell Hardness no. than other two materials.

3. CONCLUSIONS

- From the experiment it is clear that Jute/Kevlar/Epoxy laminate having 3mmthickness absorbs more energy than the other two material.
- Impact strength is less in Jute/Glass/Epoxy laminate composites compare to othertwo.
- Impact strength is more in Jute/Kevlar/Epoxy laminate composites compare to othertwo.
- Impact strength is more in Jute/Carbon/Epoxy laminate composites compare toJute/Glass/Epoxy, and less compare to Jute/Kevlar/Epoxy.
- Torque required and withstanding thrust force will be more in jute/Kevlar/epoxylaminate composites (3 mm thickness).
- Torque required and withstanding thrust force will be less in jute/Glass/epoxy laminate composites (3 mm thickness).
- Torque required and withstanding thrust force will be more in jute/Carbon/epoxy laminate composites compare to Jute/Glass/Epoxy and less compare to Jute/Kevlar/Epoxy.
- Jute/Kevlar/Epoxy laminate having 3mm Thickness shows more Rockwell Hardness no. than the other two materials.
- Jute/Glass/Epoxy laminate having 3mm Thickness shows less Rockwell Hardness no. than the other two materials.
- Jute/Carbon/Epoxy laminate having 3mm Thickness shows more Rockwell Hardness no. compare to Jute/Glass/Epoxy, and less Rockwell Hardness no. compare to Jute/Kevlar/Epoxy.

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