Design and Development of Jute Epoxy Laminate and Investigate Tensile Strength Validate by FEA Software

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Abstract

The natural fiber-reinforced polymer composite is rapidly growing both in terms of their industrial applications and fundamental research. They are renewable, cheap, and recyclable. These composites material having low density and low cost .moderate mechanical properties hence they are having attention due to easy availability and renewability of raw materials. Natural fibers have been alternative to synthetic fibers and find its applications transportation such as automobiles, railway coaches and aerospace. Other applications include military, building, packaging, consumer products and construction industries for ceiling & partition boards. This Dissertation deals with manufacturing process of Jute epoxy composite laminate with different orientation of fiber and percentage of volume fraction. Aim is Investigate Tensile strength of Jute Epoxy composite laminate. Manufacturing process for Jute epoxy composite laminate with different orientation of fiber and percentage of volume fraction is carried out. Aim is Investigate Tensile strength of Jute Epoxy composite laminate.

Keywords: Natural fiber, jute Epoxy laminates. Tensile strength, Finite Element Analysis

I. INTRODUCTION

The natural fibers are 1st time used in Egypt last 3000 years ago. The natural fibers are used to build the wall in combination with straw and clay. The polymer composite reinforced with natural fibre increase demand and attention of both industrial and academic fields. The common types of natural fibers are jute, sisal, banana, pineapple, knef, kelvar, bamboo, etc. they have moderate mechanical properties, eco-friendly cheap and non-toxic in nature. The natural fibers are used to reinforce both thermosetting plastics and thermo sets matrices. For reinforcement thermosetting resins used as epoxy, polyester, phenoic etc. the natural fiber reinforced composite find its application in building construction industry, textile industry, automobile industry. Following are the properties of natural fiber

1) Low density.
2) Easy processing
3) Easily available.
4) Cost effective.
5) Nontoxic.
6) Replacement for production technology.

A. Composite material and their properties:

The composite material consists of two or more material but during chemical combination they are soluble with each other. Thus composite is combination of two phase reinforcing phase and matrix phase. Where reinforcing phase consist of forms of fiber sheet or partials and matrix phase consist of embedded structure of reinforcing phase.
The fiber reinforced composite is preferred due to its advantages of mechanical properties like strength.
However composite materials are classified as

– On the basis of matrix:

Broadly, composite materials can be categorized into three groups on the basis of matrix material. They are:

1) Metal Matrix Composites (MMCs)
2) Ceramic Matrix Composites (CMCs)
3) Polymer Matrix Composites (PMCs)

– On the basis of reinforcing materials:

Composites materials are categorized into two groups on the basis of reinforcing materials.

1) Particulate Composites
2) Fibrous Composites.

II. FIBERS

The fiber is most important factor for fiber reinforced composite material. The material in fiber form is stronger than the use in bulk form. The fiber has strong molecular structure and in very small shaped crystal. The fiber have low density & they occupy largest volume fraction of composite the reinforced fiber only takes tensile loads but when surrounded by matrixes they are capable to take tensile, shear, compressive loads.

A. Polymeric matrix:

The polymer is divided in to two main categories thermoplastic and thermo set. The thermoplastic polymers are easily reshaped by application of heat and pressure, But thermo set plastics are not regain its shape by application of heat and pressure. The thermo set polymers are also called as resins and are used as matrix material for fiber reinforced composite. The thermo set polymer & polymer have ability to develop thermal stability and chemical resistance but they are difficult to storage for long life at room temperature.

The polymer matrix are classified in to

1) Polymer Resin
2) Epoxy resin
3) Vinyl resin
4) Phonolic resin
5) High performance resin.

B. Applications of natural fiber reinforced composite:

The natural fiber reinforced composite having following application,

1) Building construction industry
2) Storage devices
3) Furniture
4) Transportation
5) Helmets & lamp sheads

C. Manufacturing of Jute fiber epoxy composite:

Jute fiber reinforced polymer composite:

Fig. 1: Jute plant and jute fibber

The jute fiber is naturally available fiber material. It has high aspect ratio high strength to weight ratio, good insulation properties. The jute fiber is tested for door panels, windows, furniture, and beams.

D. Resin System:

Epoxy resin with grade Ly 664 and hardener Aradur 3486 is used.

III. MANUFACTURING

for manufacturing hand layup method is used before starting mfg 1st of all release gel is sprayed on mold surface to avoid sticking action of epoxy to surface of mold .The thin plastic sheets are used at top bottom of mold plate to get good surface finish to product. Reinforcement in the form of woven mat jute fabric fiber are cut as per mould size and placed at surface of mold. Then epoxy in liquid form mixed with hardener with suitable properties and applied on the mat surface finish of jute. Once one layer is properly placed then same procedure followed for second layer to get thicker of 4 to 5mm. this process is followed for manufacturing of 9 specimen .These specimens are kept at room temperature for solidification it will take 24-48 hrs for complete solidification.

A. Work Station Preparation:

Work station is prepared for all materials and tools going to be used as fundamental standard because when Epoxy & hardener is mixed the chemical composition change and hence it is limited the use as surrounding material.

B. Mould Preparation:

Before starting with layup process the adequate mould preparation must be done. This preparation consists of cleaning of mould & applying release agent in to surface of it to avoid sticking action of resin.
The following care should be taken,

1) Clean mould with clean cloth
2) Apply and spread release agent in to surface of mold
3) Buff with clean cloth.

Fig. 2: Mixing of epoxy and hardener & Applying solution to specimen

C. Experimental Testing:

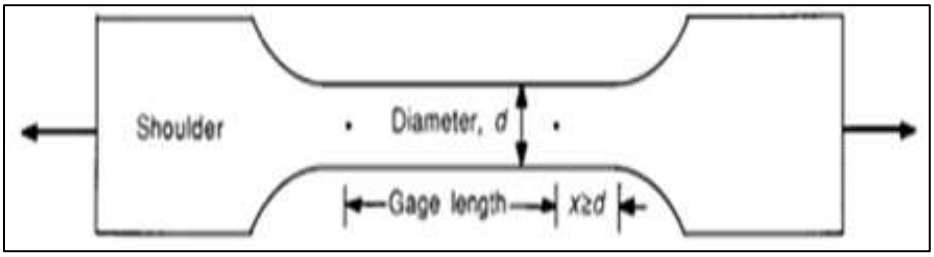


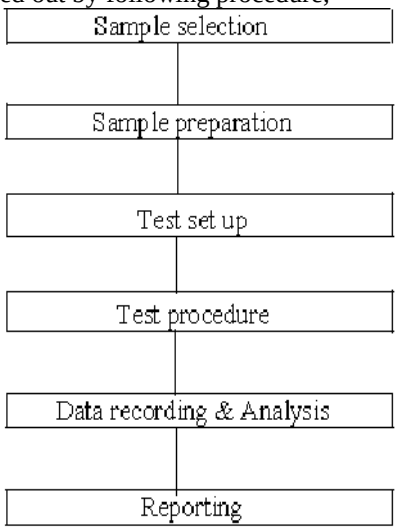
Fig. 3: Specimen for tensile test

Fig. 4: Test conducted on machine & clamping of specimen

The specimen which are manufactured are tested with the help of Universal testing Machine tensile test are performed for several resins. The results of tensile test are performed for several regions. The results of tensile test are used for selection of materials for application

The manufacturing specimens are prepared as per standard tensile test specimen the important part of specimen is gauge length the gauge length is region measure over which measurements are made & centered at reduced section. Shoulder is the part which is used as clamping purpose. The specimen is gripped between two jaws of machine the specimen should not be bend or slips from its location.

The test methodology and data analysis is carried out by following procedure;



However the testing is carried out for 9 specimens and following data is obtained

Experiment No.	*Experimental Tensile Strength*
1	*11.52 N/mm^2*
2	*2.11 N/mm^2*
3	*2.35 N/mm^2*
4	*16.00 N/mm^2*
5	*2.58 N/mm^2*
6	*3.76 N/mm^2*
7	*16.00 N/mm^2*
8	*5.64 N/mm^2*
9	*8.70 N/mm^2*

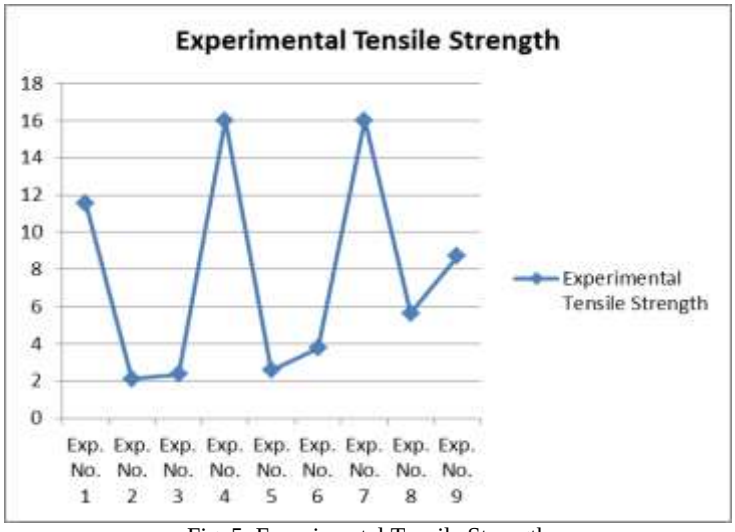


Fig. 5: Experimental Tensile Strength

D. Finite element Analysis

It is not possible to obtain exact analytical solution for any location in body because of material properties and boundary conditions.

The fabricated specimen was analyzed by using FEA software by steps includes preprocessing, solution, post processing. For FEA the fiber orientation are 0^0,30^0,45^0 are consider for 9 specimen and obtained results are tabulated as in following table.

E. FEA test results

Exp. No.	*FEA Tensile Strength*
1	*10.44 N/mm^2*
2	*2.10 N/mm^2*
3	*2.22 N/mm^2*
4	*18.74 N/mm^2*
5	*3.01 N/mm^2*
6	*4.40 N/mm^2*
7	*17.034 N/mm^2*
8	*5.97 N/mm^2*
9	*8.89 N/mm^2*

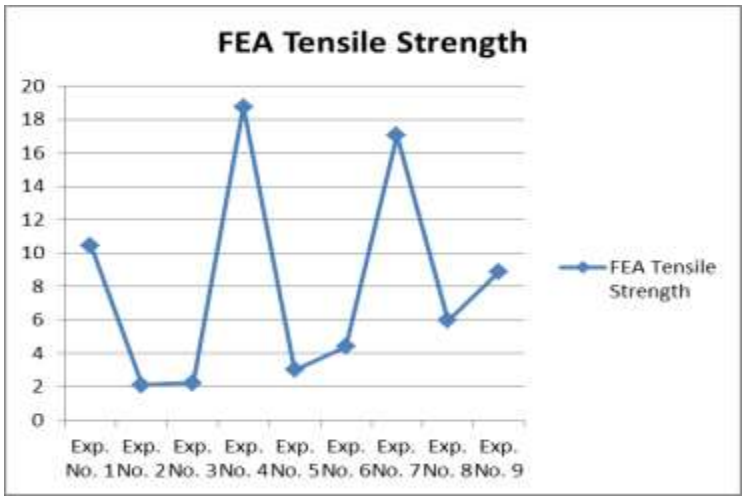


Fig. 6: FEA Tensile Strength

F. Compression between Experimental Tensile Strength & FEA Tensile Strength

Experiment No.	*Experimental Tensile Strength*	*FEA Tensile Strength*
1	*11.52 N/mm^2*	*10.44 N/mm^2*
2	*2.11 N/mm^2*	*2.10 N/mm^2*
3	*2.35 N/mm^2*	*2.22 N/mm^2*
4	*16.00 N/mm^2*	*18.74 N/mm^2*

5	*2.58 N/mm^2*	*3.01 N/mm^2*
6	*3.76 N/mm^2*	*4.40 N/mm^2*
7	*16.00 N/mm^2*	*17.034 N/mm^2*
8	*5.64 N/mm^2*	*5.97 N/mm^2*
9	*8.70 N/mm^2*	*8.89 N/mm^2*

G. Graphical Compression between Experimental Tensile Strength & FEA Tensile Strength

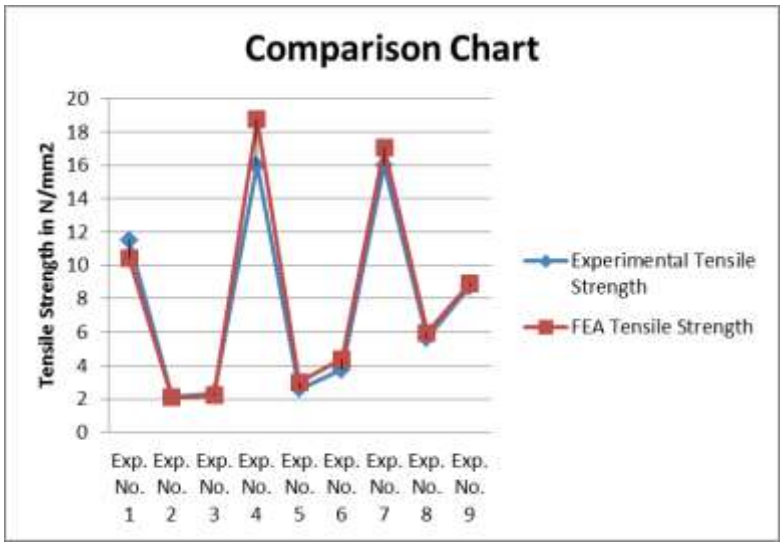


Fig. 7: Comparison Chart

IV. CONCLUSION

1) Natural fibers are easily available eco-friendly & cheap.
2) The 0^0 orientation of jute fiber epoxy laminate shows maximum strength.
3) On combination of jute fiber & epoxy resin. Fabricated specimen shows flexible behavior.
4) At 30^0 & 45^0 orientation of jute fiber composite shows tensile strength is to be minimum.
5) According to experiment tensile test 60 -40 volume fraction is better than 30-70 and 50 -50 volume fraction.
6) We get higher tensile strength at 0^0 orientation of 16 N/mm^2 & by validation of FEA we get 18.75 N/mm^2.

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