Experimental Study on Mechanical Properties of Hybrid Composite Material

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***Abstract* — Hybrid composites occupying the space of conventional materials by satisfying the requirements of different sectors like aerospace industries, Automobile industries, ship building and various bio-medical sectors. The main reason to substitute conventional materials is the hybrid composites giving same or more required properties with less weight and cost than conventional materials and maximum output in minimal consumption with better life expectancy to find the economical means of utilizing the technology for different applications. This let to huge industrial revolution and made interests on study of behavior of hybrid composites. Here an attempt is made to study, observe and compare to know the various mechanical behaviors of the hybrid composite material.**

I. INTRODUCTION

The composite technology is one of the advanced fast growing technologies in present scenario. No one has more experts to realize which the best material. But we may say some materials are stronger by comparing with other materials like composite material is continuously developing material because of high strength, less cost, easy availability etc. It is fully advanced and replacing metal by its less weight. Composite materials are used in various fields because of their high tensile strength, impact strength, stiffness, and fatigue characteristics. Because of these good properties comparing to other materials they are widely using in Aerospace industry, Automobile industry, Manufacturing of helmets, bullet proof jackets and also composite materials are using in drive shaft, brakes, Bumpers, Dash board, Engine hood etc.

As the name indicates hybrid composite material, here in this work we are using natural fiber as jute and synthetic fiber as aramid. The ultimate goal is to finding out the altered integrated mechanical properties by combining these two fibers layer by layer. There are many advantages if components are manufactured by aramid + jute fiber like less cost, high strength with less effort.

1.1 JUTE FIBER

Fig. 1: Jute fiber mat

Jute is one of the most important natural fibers. Jute is obtained from jute plant hence jute has one popular name as golden fiber because of its high strength it can be used in many applications such as packing materials, door manufacturing, and boat industry. Sometimes jute is blended individually used in the production of apparel. Two major sources of jute are India and Bangladesh. In jute fiber the fibers are bounded by using special type of sticky material which keeps the fibers bundles tightly. In this soft tissues should be softened, dissolved then washed away then only fiber can be obtained from the steam. This process is known as retting. Fig-1 shows the normal jute fiber mat.

A. Aramid fiber

Synthetic fibers are those which are made by humans with chemical synthesis, these are the results of extensive research by scientists to improve on naturally occurring fibers. Aramid fiber is one of the synthetic fibers. This Aramid fiber reinforced composite materials are increasingly popular over the years. Its application is considerably vast due to its excellent mechanical properties, lighter weight, unique flexibility, corrosion resistant, ease of fabrication etc. compared to other conventional metallic materials. Aramid fiber possesses very unique properties. It can be viewed as nylon with extra benzene rings in the polymer chain for increasing its stiffness. It is mainly popular for its applications

in industrial and advanced technologies like ballistic armor, helicopter blades, pneumatic devices, sporting goods etc.

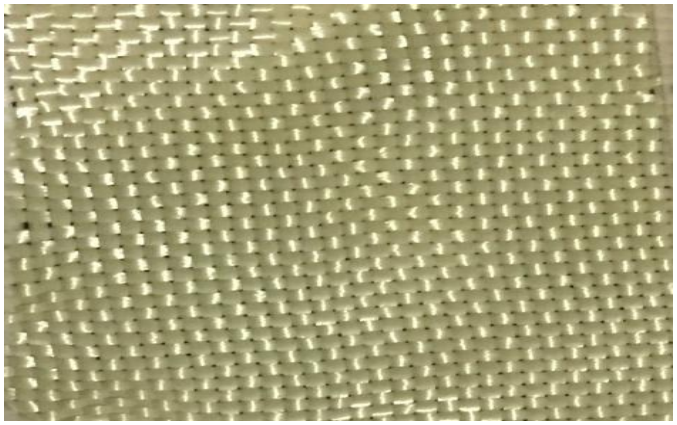


Fig. 2: Aramid fiber mat

Compared to other synthetic fibers, it possesses significantly lower fiber elongation and higher tensile strength and modulus. Fig-2 shows the aramid fiber mat.

II. LITURATURY SURVAY

a) "Mechanical Properties of Kevlar/Jute Reinforced Epoxy Composite" September 2016, By N.O.Warbhe, Ramakant shrivastava & P S Adwani. In order to conserve natural resources and economize energy, weight reduction has been the main focus of automobile manufacturers in the present scenario. Weight reduction can be achieved primarily by the introduction of better material, design optimization and better manufacturing processes. The introduction of composite materials made it possible to reduce the weight of component without any reduction on load carrying capacity and stiffness. The composite materials have more elastic strain energy storage capacity and high strength to weight ratio. The composite material offer opportunities for substantial weight saving but not always are cost-effective over their steel counter parts. A composite material is a material in which two or more distinct materials are combined together but remain uniquely identifiable in the mixture. The most common example is, perhaps, fiber-glass, in which glass fibers are mixed with a polymeric resin. If we break the composite, the fibers and resin would be easily distinguished

b) "Aramid fibers- An overview" September 2001 By M. Jassal & S. Ghosh. Preparation and structure of aramids in general and nomex and Kevlar aramid fibers in particular are discussed, the structure property correlation and the application areas of these fibers are reviewed.

c) "Experimental investigation on mechanical properties of Kevlar fiber" July -2017 By Fasil Mohi ud-din. The experimental investigation was carried out on various types of fibers to find the use of the fiber in the structural engineering in particular and civil engineering in general. Various testing procedures were adopted to find the effectiveness and compatibility of fiber in concrete. In this paper the study was conducted about engineering and mechanical properties of Kevlar Fiber and in comparison with other fibers, testing of Kevlar fiber under various conditions and the very systematic comparative study was been carried out on the properties of Kevlar with respect to other fibers. The main objective of the study is to find out the mechanical properties and compatibility of fiber so that it can be used in concrete to enhance its properties and to increase its durability.

d) "Fabrication and characterization of Kevlar/Jute Reinforced Epoxy" Sep -2017 By Shashidhar patil, Praveen B.A, Dr. U.N.Kempaiah & Dr. Adarsha.H. With a specific end goal to ration common assets and conserve vitality, weight decrease has been the principle center of vehicle producers in the present situation. Weight decrease can be accomplished fundamentally by the presentation of low thickness materials. So the Industry has demonstrated increment enthusiasm for supplanting of steel material with that of composite material. The point of this work was to decide the rigidity, Modulus of versatility, flexural quality, affect quality, weight and cost of Kevlar-Jute composite. Epoxy SE 70 grid was utilized for the composite of Kevlar and Jute. Test tests were readied utilizing pressure shaping. This is an outstanding method to create composite items. Diagnostically, the volume portion and weight division, rigidity, modulus of versatility, weight and cost of composite example was figured. Trial test led on example utilizing Universal Testing Machine (UTM). The outcomes demonstrated that the properties of Kevlar-Jute composites can be extensively enhanced by joining of Kevlar in jute fiber composites upgrading the properties of coming about half breed composites. Stacking arrangement (modifying the position of Kevlar handles) altogether influences the flexural quality. For a similar relative weight division of Kevlar and Jute fiber, layering grouping has little impact on tractable properties. The Kevlar to jute proportion builds the ductile, flexural quality, affect vitality, strain vitality and lessens the heaviness of example. Progressively the Kevlar rate brings down the epoxy rate so the cost is lessened of example.

e) "Study of Tensile Behavior by Variation of Kevlar to the Jute Fiber Epoxy Hybrid Composites" June – 2017, By Bhanupratap R & H.C Chittappa. Hybrid composites are occupying the place of conventional materials by meeting the requirements of the industries, aerospace, mechanical, space, construction, and biomedical applications. But the desire of achieving the higher modulus to density ratio always remains starved as it requires the maximum output in minimal consumption with better life expectancy to find the economical means of utilizing the technology for different applications. Here an attempt is made to study, observe and compare to know the tensile behavior of the hybrid polymer composite material. From the result, increased

layer of Kevlar to the jute fiber shows improvement in the tensile strength and tensile modulus.

f) "Effect of Hybridization of Glass/Kevlar Fiber on Mechanical Properties of Bast Reinforced Polymer Composites: A Review" January 25, 2017. By Sandeep Kumar, Lalta Prasad, and Vinay Kumar Patel. Natural fibres are gaining more and more interest as reinforcing materials for polymer composite due to their environmental and economical benefits. Bast fibers is a prominent reinforcement for use in polymeric materials because of its low specific weight and cost, eco-friendly and abundantly available in nature. Several authors manifest the cellulosic fibers based polymeric composites as advantageously used in automobile industries and structural applications, but certain problems have been associated during usage of such fiber such as high water/moisture-uptake and low strength than inorganic fibers. These problems have been reduced to a major extent with enhancements in mechanical properties by the researchers through hybridization of these natural fiber based composites with synthetic fiber (glass/Kevlar). In the present article, we reviewed the effect of hybridization of glass/Kevlar synthetic fibers on mechanical properties of bast fiber (jute, hemp, kenaf, flax) reinforced polymer composites.

III. OBJECTIVES

The objectives of this project are as follows:

- The primary objective of the present work is to fabricate composite laminates with: Jute fabric + aramid fiber + Epoxy resin using simple hand layup technique.
- To prepare test specimens for flexural test, tensile test, compression test and impact test from the above fabricated laminates.
- To conduct tensile test, compression test, 3-point flexural tests and impact test.
- To acquire different outcomes for these tests and Displacement at Ultimate Load and to think about the qualities got for these samples.

IV. METHODOLOGY

A. Preparation of resin

After curing of gel coat the resin mixture is prepared, which consist of resin grade epoxy LY556 and hardener 951. It is mixed in the ratio of 100:15 that is 100gms of resin and hardener of 15gms and stirred it constantly.

B. Preparation of mould

The wooden mould or die is prepared for making the composite slab of size 150×200×6 mm. The mould is tightened by number of nut and bolts at each side as shown in the figure-3

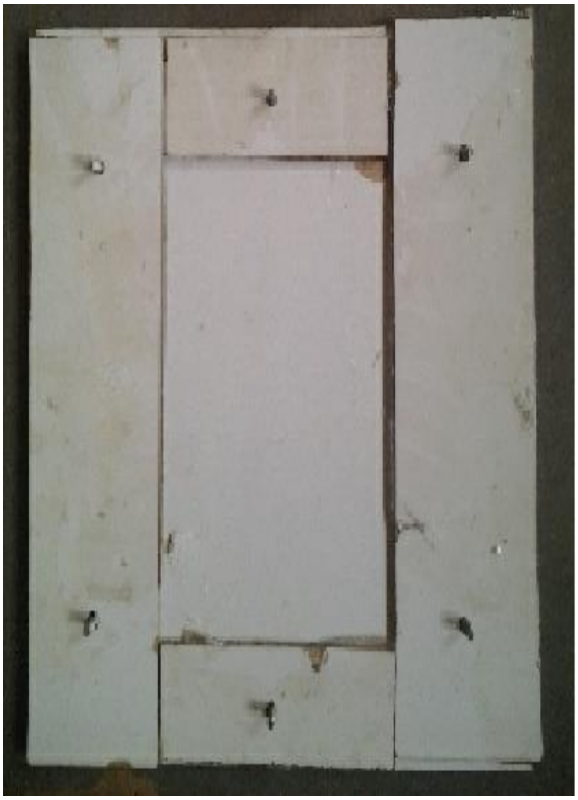


Fig. 3: Wooden mould

C. Fabrication of Composites

The fabrication of composite slabs is carried out by hand layup technique as shown in fig-4. In this method bidirectional jute and aramid fiber are using as reinforcement and epoxy resin is using as matrix material.

Steps in manufacturing of the composite test particles.

- In first step surface of the mould should be cleaned once the surface is cleaned we have to apply wax for easily removal of end product.
- Over the gel coat resin has to be applying with the help of brush then required mat is placed over the resin and rolled with the help of roller its helps to removal of air bubbles.
- Then again resin applied over the matt with the help of brush then again matt is placed over resin and rolled with the help of roller the same procedure is repeated until to get required thickness.

Once the fabrication of natural and hybrid composite materials are over the specimen is subjected to various mechanical tests. Here natural fiber is combined with aramid fiber test particles are undergo mechanical observations.

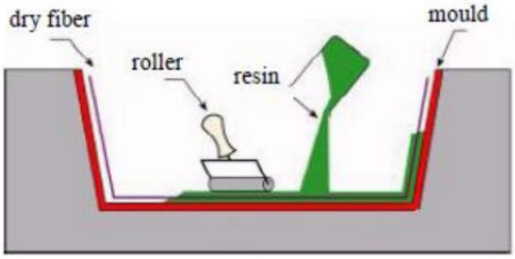


Fig. 4: Hand Layup Method

TABLE 1: Materials Details

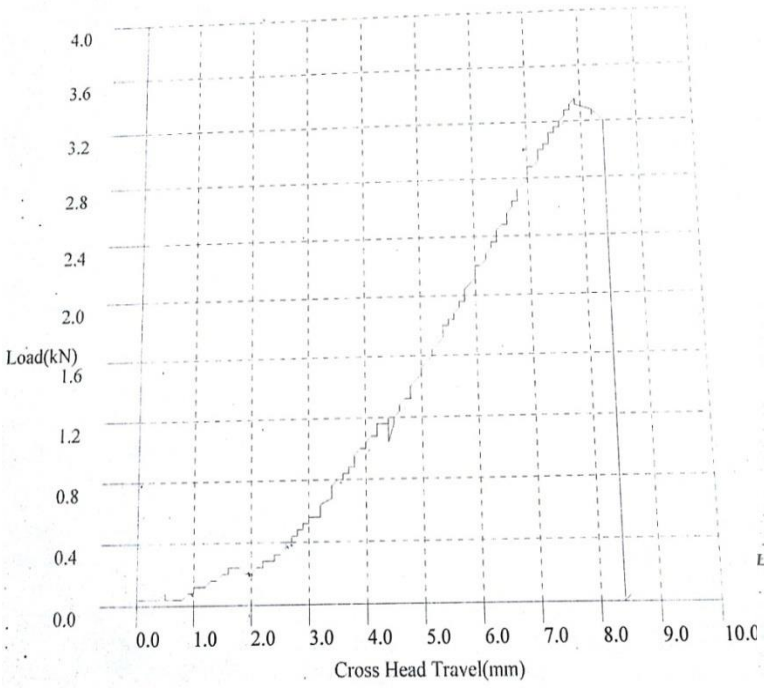
Reinforcing Fiber	Jute Fiber & Aramid Fiber
Matrix System	Epoxy Resin (LY556) and Hardener 951
Molding Process	Hand lay-up followed by Room temperature molding.
Reinforcements: matrix ratio	100:15

V. RESULT AND DISCUSSION

A. Tensile test

TABLE 2: Tensile Test Results

Material dimension (mm)	Peak load (kN)	Maximum displacement (mm)	Ultimate tensile strength (N/mm^2)
Initial width =11.6 Initial thickness =3.5	3.36	7.9	82.76

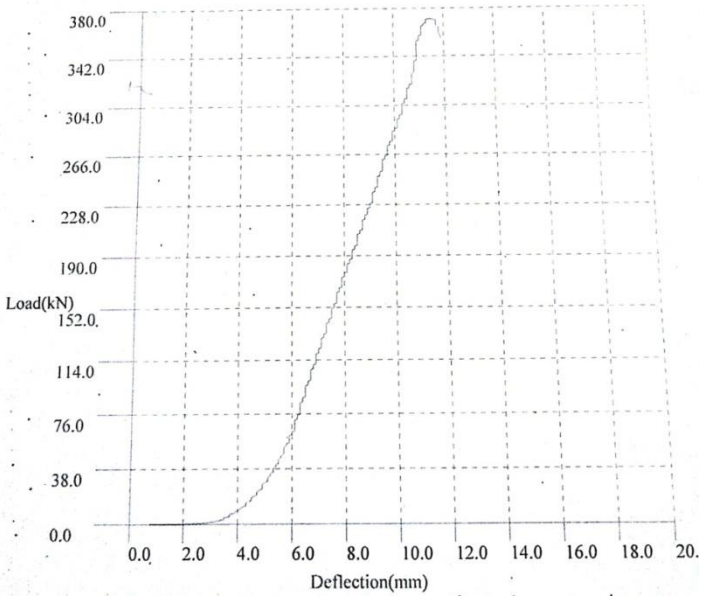


Graph 1: Tensile Test

B. Compression test

TABLE 3: Compression Test Results

Material dimension (mm)	Peak load (KN)	Maximum displacement (mm)	Ultimate tensile strength (N/mm^2)
Initial width =45 Initial thickness =45	371.72	11.5	183.57

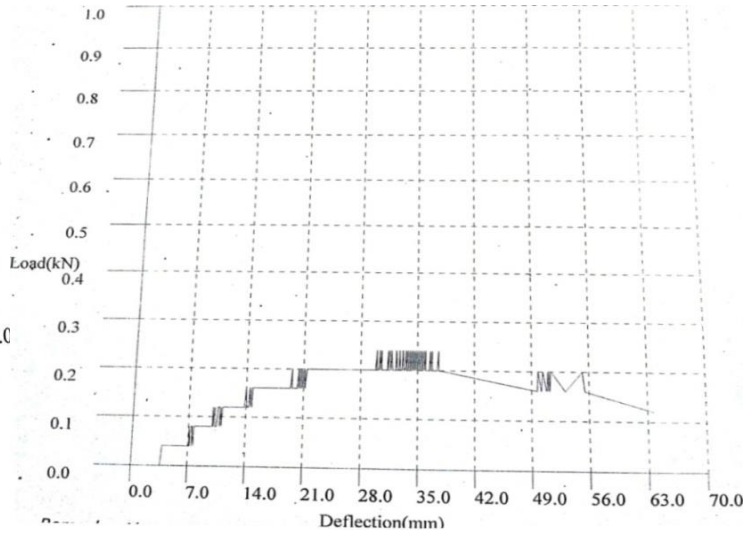


Graph 2: Compression Test

C. Flexural test

TABLE 4: Flexural Test Results

Material dimension (mm)	Peak load (KN)	Maximum displacement (mm)	Ultimate tensile strength (N/mm^2)
width =37 thickness =4	0.24	200	60.81 (It has not shown any fracture)



Graph 3: Flexural Test

D. Impact test:-

Charpy test

Energy absorbed by the specimen (k) =3.5J
Impact strength of specimen=k/A =3.5 /50= 0.07J/ mm^2.
Cross sectional area (A) =10×5 = 50 mm^2.
Length of the specimen (L) = 55mm

Izode test

Energy absorbed by the specimen K= 6J
Impact strength of the specimen = 6/80 =0.12 J/mm^2.
Cross sectional area (A) =10×8 = 80 mm^2.
Length of the specimen (L) = 75mm.

VI. CONCLUSION

This experiment of mechanical properties of natural and hybrid composite reinforced epoxy composites have to the following conclusions:

- The result obtained by the Hybrid laminated composites which is JUTE+ARAMID shows the very good flexural strength even after applying 90^0 bend with 0.24KN of load, the specimen has not shown any fracture.
- The compression strength of the specimen is very high and has not shown any fracture up to 371KN.
- Peak Tensile strength of the hybrid composite is 82.75N/mm^2 which is greater than peak tensile strength of cast steel sheet.
- This aramid + jute hybrid composite material is of very less weight with grater strengths.
- The components produced by ARAMID+JUTE fiber can be manufactured with less possible cost which exhibits excellent require mechanical properties.
- The method involved in manufacturing of composite material is very easy as compared to conventional manufacturing.
- More the Kevlar percentage lowers the epoxy percentage so the cost of specimen is reduced.
- The Kevlar to jute ration increases the tensile compressive, bending strength, flexural strength and reduces the weight of specimen.
- In this study it is observed that the thickness of the composite enhances the tensile strength due the addition of aramid which is required for the dynamic loading applications.

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