Mechanical Characterization of Polymer Matrix Composites for Transportation Safety Application

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ABSTRACT:- *The present study is carried out on a polymer hybrid composites prepared by Kevlar glass fiber reinforced epoxy composites fabricated by hand layup technique at specific configuration. The compression test was conducted on the prepared composite, which is hollow tube as per standards. The Kevlar in the hybrid system showed a great resistance to compressive load and withstood a great amount of external compressive loading before it buckled and this indicated the possibility of a hollow tube can be used for withstanding greater loads that can be used for energy absorption that can be used for automobile safety.*

Key Words: Kevlar, glass, compressive, safety, hybrid.

1. INTRODUCTION

Composite materials are prepared by combining two or supplementary materials to give an exceptional mixture of properties. Many general materials are definitely "composites," including wood, concrete, and metals alloys. Kevlar 29 impact challenging composites are commonly in use for a wide range of applications including ballistic opposed to armor. Development in the composite's energy absorption and the decline of weight are critical for greater than ever their helpfulness in application. Laminar composites are originated in as many combinations as the amount of materials. They can be described as resources comprising of layers of materials bonded together. These may be of numerous layers of two or more metal resources occurring alternately or in a firm order more than once, and in as many figures as required for a definite purpose. Polymers make ideal resources as they can be processed simply; possess small fry, and popular mechanical properties. It follows, therefore, that high temperature resins are comprehensively used in aeronautical applications. Two main kinds of polymers are thermosets and thermoplastics. Thermosets have character such as a well-bonded three-dimensional molecular organization after curing. The Fibre-hybrid collected of two or further fibre types in a matrix. Such composites offer other design freedom than non-hybrid composites system. The tubular structures in energy withstanding tubes nowadays are made-up from a range of strong substance such as metallic, synthetic fibre and hybrid composite fibre which reinforced with various type of polymer. The essential awareness into scheming the hybrid force absorption tube into certain criterion of manufacturing design.

2. LITERATURE SURVEY

The evolution of composites materials has replaced most of the conventional material of construction in automobiles, aviation industry etc. Fibre reinforced composites have been widely successful in hundreds of applications where there was a need for high strength materials.

Norazean Shaariet. al. has conducted study on "Impact resistance properties of Kevlar/ glass fiber Hybrid composite Laminates", composite consisting of Kevlar-49 with C-glass fiber and Mocrete BJC resin. Physical and Mechanical test was conducted with different ratio of Kevlar to glass fiber according to ASTM 7136 and the result obtained shows that addition of Kevlar to glass fiber has improved the load carrying capability, energy absorbed and damage degree of the specimen. These results proved that Kevlar showed better resistance towards impact loading. **Joselin et. al** has carried Investigation on Impact strength Properties of Kevlar fabric using Different Shear Thickening Fluid Composition, the composite consists of shear thickening fluid, Kevlar Fabric and Silane Coupling Agents. Impact Tests was performed, which were based on the NIJ standards 0115.0 for stab resistance body armor. The result obtained shows that when compared with neat Kevlar fabrics and unmodified Kevlar fabrics, the functionalized STF based Kevlar fabrics provides more protection, yet it is much thinner and more flexible. **Young S Lee et. al** has conducted examination on the ballistic impact characteristics of Kevlar woven fabrics impregnated with a colloidal shear thickening fluid. The composite material composed of woven Kevlar fabric impregnated with a colloidal shear thickening fluid. Fragment simulation projectile ballistic penetration measurements at ~244 m/s have been performed; the results demonstrate a significant enhancement in ballistic penetration resistance. **Zhu et. al** conducted experimental investigation on "Penetration of laminated Kevlar by projectiles". An experimental investigation of the static and dynamic penetration of various Kevlar/ polyester laminates primarily by sharp-pointed projectiles has been conducted for various laminate constructions, target thicknesses and impact speeds. Kevlar laminates exhibit better impact resistance to cylindro-conical projectiles on a specific weight basis when compared to aluminum. **Marom et. al** has done a research on impact behavior of carbon / Kevlar hybrid composites. Composites and hybrid were made of Araldite F/HT 972 epoxy resin reinforced by Kevlar 49 fibres and ACIF-HT, surface untreated carbon fibres. Hybridization of carbon fibre-reinforced composites with Kevlar fibre results in a significant positive hybrid effect in the impact energy, when the hybrid is in the form of a sandwich with the Kevlar fibres placed in the outside layers. In that structure the impact properties of the Kevlar parent composite are nearly attained by replacing 50% of the carbon fibres with Kevlar. **Jogiet. al** study on evaluation of Impact Strength of Epoxy Based Hybrid Composites Reinforced with E-Glass/ Kevlar 49. In Hybridization, layers of E-glass and Kevlar 49 fabrics stacked with epoxy resin. Mechanical properties such as impact strength, bear resistance and break resistance were analyzed by using ASTM D-256 and D-3763 standard. Experimental investigation was conducted using instrumented Dart impact and Izod Impact test. E-glass/Kevlar 49 at layup 0°/90°and 30°/60°exhibited improved impact strength than 45°/45°. **Yehet. al** Studied compressive response of Kevlar/Epoxy Composites and concluded that compressive strength based on fiber micro buckling is suitable for composites with a very high fiber shear modulus. Since Kevlar 49 fiber has a very low axial shear modulus, the compressive behavior of Kevlar/epoxy composites is dominated by local shear failure. **Girish Gautamet. al** have studied Mechanical Characterization of Kevlar-29 Fiber Reinforced Polymer Composite, the laminate composite panel specimens were prepared by incorporating Kevlar-29 fiber in epoxy polymer resin. Tensile test, flexural test and impact test was performed to evaluate the tensile and impact strength and concluded that average tensile strength of the fabricated specimen is 304 MPa, flexural strength of 182.6 MPa and impact strength of 1.47 J/m.

3. FABRICATION

3.1 Tube Preparation

An initial preparation of all the materials and tools that are going to be used is a fundamental standard procedure when working with composites. This is mainly because once the resin and the hardener are mixed, the working time (prior to the resin mix gelling) is limited by the speed of the hardener chemically reacting with the epoxy producing an exothermic reaction. Also, as part of the initial preparation, the woven cloth must be cut according to the shape of the part.

3.2 Mold preparation

Before starting with the hand layup wrap process an adequate mold preparation must be done. Mainly, this preparation consists of cleaning the mold and applying a release agent in the surface of it to avoid the resin to stick. Here the mold preparation is simply taping the plastic sheet to the plastic pipe. The procedure followed: Clean the mold with a clean cloth. Then Apply and adhere release film on the surface of the mold with a help of adhesive tapes. Wait certain time to set up the release film, Buff the outer region with clean cloth.

3.3 Hand Lay-up wrapping process

The first step is to mix the resin (Epoxy L12) and the hardener (K6). The proportions are usually dependent on the weight of the reinforcement materials. The mixing is performed in the mixing containers with the mixing stick and should be done slowly so as to not entrain any excess air bubbles in the resin until exothermic reaction occurs.

Fig - 1 Measurement of Epoxy mixture

Next an adequate quantity of mixed resin & hardener is deposited in the mold and a brush or roller is used to spread it around all surface, It is important not to add too much resin, which will cause too thick of a layer, nor to add less than the necessary amount, which will cause holes in the surface of the part when it is cured.

Fig - 2. Application of Matrix

The first layer of fiber reinforcement is then laid (here Kevlar). This layer must be wetted with resin and then softly pressed using a brush to make the resin that was added in the previous step wick up through the Kevlar woven cloth. If the fiber is not completely wet, more resin can be added over the top and spread around.

Fig - 3. Wrapping of Fiber

After this stage a second layer of Glass fiber is added and special care must be taken to eliminate all air bubbles possible. This can be accomplished by either rolling or brushing out the bubbles formed. This step is repeated until the desired configuration is obtained. As the fiber layers are added to build laminates and total part thickness. After the final layer of fiber is placed an outer coating of resin is made and release film is wrapped on it and secured with the adhesive tape.

3.4 Curing

The part can be cured at elevated temperatures using an oven or at room temperature. Generally, the proper curing time of each type of resin-hardener, as well as the working time, is given by the supplier on the back of the containers. For the purposes using an epoxy resin system, room temperature curing is adequate. And the part is kept in the designated untouched area for 24 hours of curing with little or no application of load.

3.5 Removing the part from the mold and Cleaning

Once that part is ready and cured, it must be removed from the mold and excess materials must be trimmed off, and also as post curing process the part can be cut to required shape and dimensions.

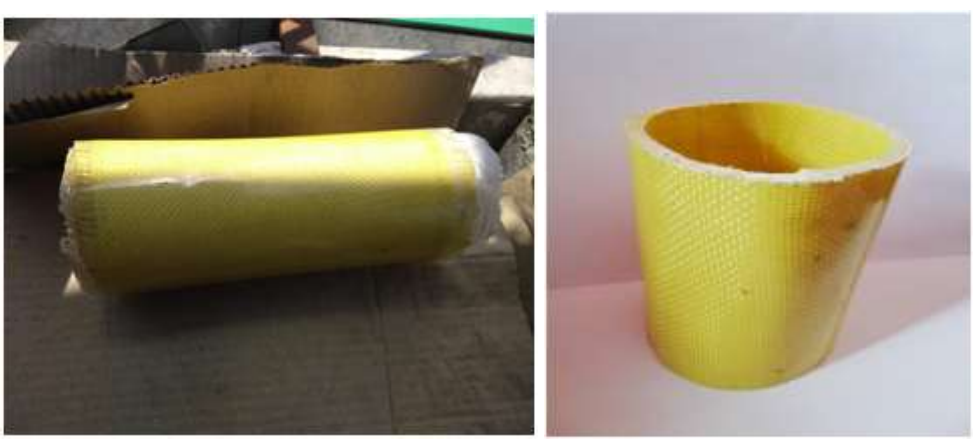

Fig - 4 Finished Component

All the materials used (brushes, mixing tools, scissor), including the table, must be cleaned using acetone and cloth. Also, the rest of the fiberglass woven reinforcement must be collected from the table and floor and disposed of in safe manner.

4. RESULTS & DISCUSSION

The Energy Tube manufactured by hand layup wrapping method, after the compression test carried out in Universal Testing Machine Produced the following result as shown in Table 1 and Graph of load v/s Deflection shown in Fig 5.

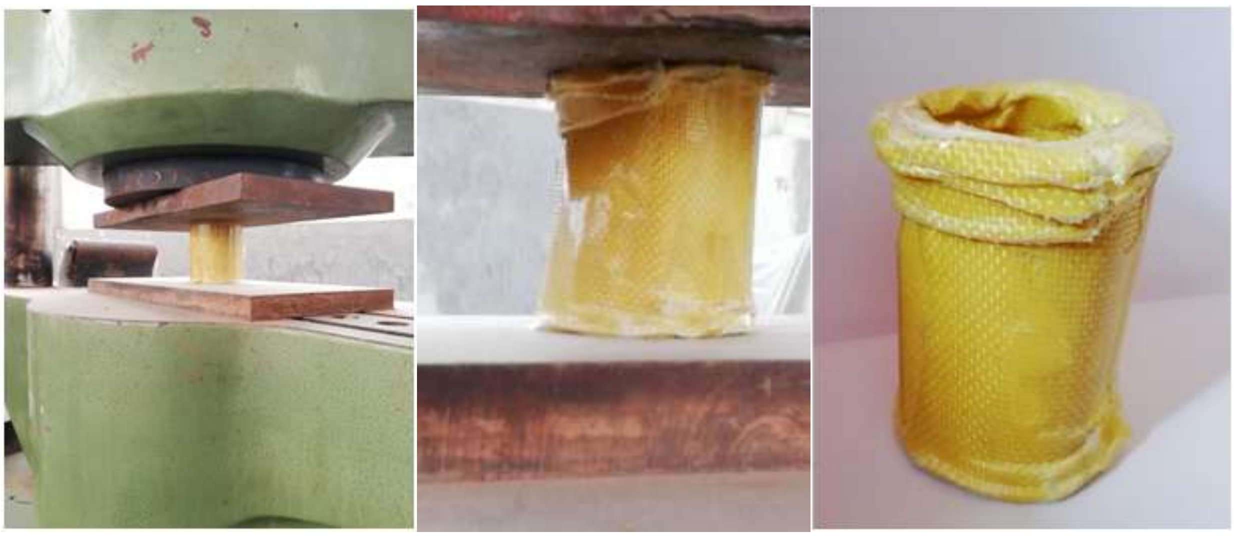

Fig - 5. Sample under compression test

Table - 1 Compression test of Energy Tube made out of hybrid composites

Sl. No	Material Code	Maximum Compressive Load (KN)	Maximum Compressive Stress (MPa)	Young's Modulus (MPa)
1	Conf 1	58.40	82.13	2656.66

Chart - 1 Load V/S Deflection Graph Of compression test

5. CONCULSION

Considering the optimal configuration from the laminates prepared, the fabrication of energy absorption tube of the first configuration was selected and fabricated. In order to assess its compressive property of the developed energy tube compression test was carried out and it was found that the tube withstood about 58 KN load with 82.13 Mpa compressive strength of to sustain compressive load.

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