© 2018 IJSRSET | Volume 4 | Issue 11 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section : Engineering and Technology
DOI : https://doi.org/10.32628/IJSRSET21841126

Evaluation of Mechanical Properties of Jute and Kevlar Fiber Reinforced Materials

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ABSTRACT

The purpose of this paper is to investigate the mechanical properties of kevlar fiber and jute fiber reinforcement. Nowadays the composite materials are widely used materials. Having wide range of applications due to its light weight, high strength and low cost. These composite materials are now being explored in applications of aerospace and automotive industries. In the present work, the composite material is prepared with intermediate aramid fabric layer (Kevlar) which is high strength fiber and it is combined with jute fabric reinforced epoxy composite to increase the strength of kevlar. This composite material is tested for mechanical properties like flexural, tensile & impact strength are calculated with UTM (universal testing machine) for flexural, tensile tests and impact testing is done with impact testing machine. Through this test results the impact strength of the composite material is calculated. The energy dissipation by impact test of jute and kevlar fabric composite and strength of fibers will be analyzed by scanning electron microscopy (FESEM). Thermo gravity analysis (TGA) and differential thermal analysis (DTA) is carried out. Through these test results it can conclude that the jute can be combined with the kevlar where the impact is primary considerations like bulletproof vests, automobile bodies, tyres etc. The usage of jute in all kevlar applications will increase the strength of kevlar by reducing the usage of Kevlar and cost will be minimized.

Keywords : Electron Microscopy, Differential Thermal Analysis, Thermo Gravity Analysis, Jute Fabric Composite, Aramid Fibre.

I. INTRODUCTION

Composite materials are widely using materials in all engineering applications as well as in general applications also. Composite materials have made immense usage in many industries as replacement for metals. Composite materials are the combination of two or more materials, these materials combines and gives better properties when compared to the individual properties of the materials. By combining these two materials we can get the unique properties of composite. Composite materials are typically composed of a binding matrix of various different materials (e.g ,metallic, polymeric, ceramic, etc.), reinforced by inclusions having different shapes (long and short fibers, whiskers, flakes, filaments) In these composites we can easily identify the materials as they do not dissolve or blend in to each other. Composite materials are generally used in the construction of buildings and bridges, structures, construction of ship building, automobile body buildings. Mostly advanced composites are used to

make the aircrafts and space craft's in aerospace industries. The main advantage of these materials with respect to the metals are these materials having the good mechanical and chemical properties such as higher stiffness, high toughness, lower corrosion, lower weight, less cost, ease of fabrication etc .

In the present work the composite material is prepared with the compositon of kevlar and jute fibers.kevalr is aaramid fiber. Kevlar is stronge material than the steel. Kevlar is made by a condensation reaction of an amine (1, 4-phenylene-diamine) and acid chloride (terephthaloyl chloride). The Kevlar chains are relatively rigid and tend to form mostly planar sheets, similar to those of silk and it is costly fiber. The jute fiber is a natural fiber which is easily available in nature. It is also having good mechanical properties.

In the present work is polymer matrix composite and based on reinforcment material structure it is a fibrous reinforced composite sturcture is used. In the present work the araldite polymer is used and the fiber materials are jute fiber and kevlar fiber. the jute fiber is a natural fiber and kevalr is a aramid fiber. polymer matrix composites (PMC) are popular due to their low cost and simple fabrication methods. The main part of compiste materials is reinforcment. Based on the reinforcing materials the composite material strength is depended. The jute fiber is extracted from the jute plant and kevlar is a aramid fiber.. In the present work the jute and kevlar fiber reinforced compiste is prepared and it is investigated mechanical properties and fibers stregnth is amalysed by FESEM and theraml properties are analysed by TGA/DTA.

II. METHODS AND MATERIAL

In the present work, jute fiber (natural fiber) and kevlar fiber (aramid fiber) were used as a reinforcement areshown in figure 1. In this epoxy resin araldite (LY556) is used as a matrix and hardener (HV951) are used are shown in figure 1.the chemical name of LY556 is "Diglycidal ether of bisphenol A(DGEBA)" and HY951 chemical name is "Triethylenetetramine (TETA)". the resin and hardener were mixed in the ratio of 100:10 was used to obtain optimm matrix composition [6].the resin and hardener were purchased from a authorizd chemical dealers.mould realsing agents OHP sheets and wax are used in the fabrication [7].

(a)

(b)

(c)

Figure 1: (a) Epoxy resin (LY556) and Harener (HY951), (b) Kevlar fiber, (c) Jute fiber

The jute and kevlar fiber mechanical properties are tabulated in table 1.

Properties	Jute fiber	Kevlar fiber
Density (g/cm³)	1.3	1.44
Youngs modulus(GPa)	26.5	70.5
Elongation at break (%)	1.5-1.8	3.6

Table 1. properties fo fibers

Simillarly the epoxy resin (LY556) has the 1.16 g /cm³ density and hardener HY951 has 0.95 g/cm³ denisty. The epoxy and hardener are mixed in proper ratio 100:10 i.e. 100 grams of epoxy is added with 10 grams of hardemer and it is thouroughly mixed. Increasing the hardener proportion in the chemical solution will gives brittle properties [8].

III. FABRICATION PROCESS

In the present work the two test specimens of different dimensions are prepared, one specimen is for the tenisle and flexural testings another one is for the impact testings by chorpy and izod methods. The tensile and flexural test specimens of dimensions 130*130*3mm are named according to their fiber composition K1J1, K2J1, K1J2. The tensile specimens of dimensions 150*150*10mm are named as 124, 125, 126, 128. The composition of fiber list is tabulated in table.2and table 3 respectively.

Table 2. impact test fiber composition

Specimen name	fiber composition	
	Jute layers	Kevlar layers
124	4	12
125	5	12
126	6	12
128	8	12

Table 3. for tensile and flexural test fiber composition

Specimen name	fiber composition	
	Jute layers	Kevlar layers
K1J1	1	1
K2J1	1	2
K1J2	2	1

In the above table.2 the jute and kevlar fiber composition of the impact specimens are tabulated and similarly in the table.3 the fiber composition of the jute and kevlar fibers for the tensile and flexural testing's tabulated. The fabrication process of the test specimen's step by step method is shown in below figure.2.

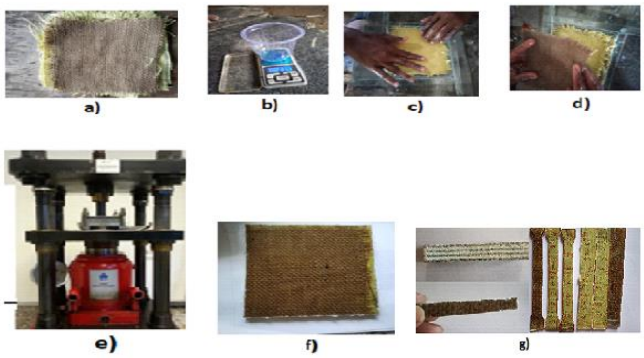

Figure 2. Fabricating Specimen

a)Jute and kevlar fibers arrangement b) Weighing of matrix and hardener c) Arranging fibers in a mould after dipping in the matrix solution (kevlar) d) Arranging of fibers one after another after dipping in matrix solution (jute) e) Compressing mould by pressing machine f) Prepared sample for impact specimens g) final test specimens.

To prepare the specimens the two different mould cavities are prepared with different dimensions as mentioned above. These mould cavities are prepared by using glass plates and the OHP sheets. The wax material is applied for the glass plates to prevent the adhesion of the matrix to the glass plates.

IV. EXPERIMENTAL PROCEDURE

The tensile specimen tested per standards D7205 / D7205M - 06(2016) and used UTM Machine Inston D3339 for tensile testing. Flexural specimen is also tested as per test standards ASTM D7264 and used UTM Machine Inston D3339 for flexural testings. The tensile test specimens of dimensions 130*130*3mm are placed in the upper and lower jaws of machine and applied load on it and at specific load the breakage of the specimen occurs and the readings are noted. Similarly the flexural test specimens of dimensions 130*130*3 mm are placed on the two supports horizontally. Then, load was applied gradually to the middle of the specimen by roller. At a specific load the sample is break, i.e. fracture is occurred. For the gradually increasing deformation of the specimen, the respective load is noted and further calculation is performed to find the bending strength of the specimens. The similar work is carried out for the three specimens.

The izod and chorpy impact testing's carried out for the specimens to know the impact strength of the specimens. for the chorpy testing the test specimen dimensions as per the ASTM D6110-10 are 55*10*10 mm are taken and it is placed horizontally on fixture of the impact testing machine. When the pendulum is released the hammer of the pendulum will strike the specimen and then initial and final readings are noted. Similarly for all the test specimens the readings are noted. For the izod test the dimensions of the test specimens are 62.5*10*10mm. these are placed vertically on the fixture. When the pendulum is released, the pendulum hammer will strike the specimen and the readings of initial and final are noted. Through these izod and chorpy readings the impact strengths are calculated.

V. EXPERIMENTAL RESULTS AND ANALYSIS

The composite material is tested under UTM (universal testing machine) and samples left to break till the ultimate tensile and flexural strengths occur. Experimental results are tabulated in the table 3 & 4.

Table 4. Tensile Test

Specimen Name	*Tensile Stress (Mpa)*	*Flexural stress(Mpa)*
K1J1	42.50	34.33
K2J1	79.86	143.52
K1J2	41.45	96.37

Table 5. Impact (Charpy &Izod)

Specimen name	Impact strength (j/mm^2)	
	Izod	Chorpy
124	1.96	4.96
125	1.92	5
126	2	5.04
128	2.12	5.08

In the above table.4 the tensile and flexural stresses are calculated for the specimens. In that the specimen K2J1 has the good tensile and flexural stresses when compare to the other two specimens. For K1J2 flexural stress is good but tensile stress is less and for K1J the tensile stress is slightly good but flexural stress is very poor. So for these specimens we can say that the use of jute fiber to the kevlar fiber will give the good tensile and also flexural properties i.e.K2J1.

In the impact testing the chorpy and izod test results are tabulated in the table.5. the impact strengths are calculated for the different test specimens. In that specimens 128 specimen i.e.12 layers of kevlar and 8 layers of jute fiber composition has given the good impact strength in the chorpy and also in izod tests. From this we can say that the impact strength is increases when use the combination of jute and kevlar fibers. The test specimens after the tensile , flexural and impact tests are shown in below figures3 & 4.

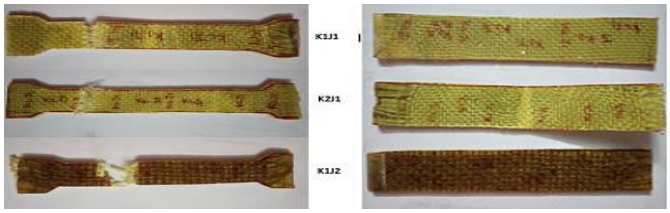

Figure 3. test specimens after tensile and flexural tests

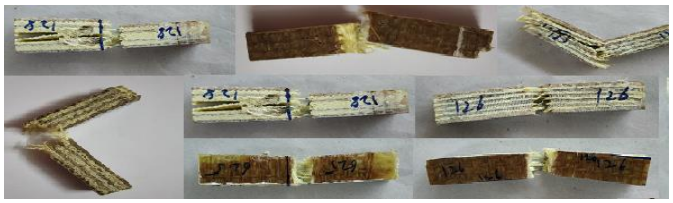

Figure 4. test specimens after izod and charpy impact tests

VI. MORPHOLOGY

In order to know its micro structures of fiber layers and the bonding between the matrix solution and jute, kevlar fiber layers are examined by FESEM microscopic analysis as shown in figure 5.

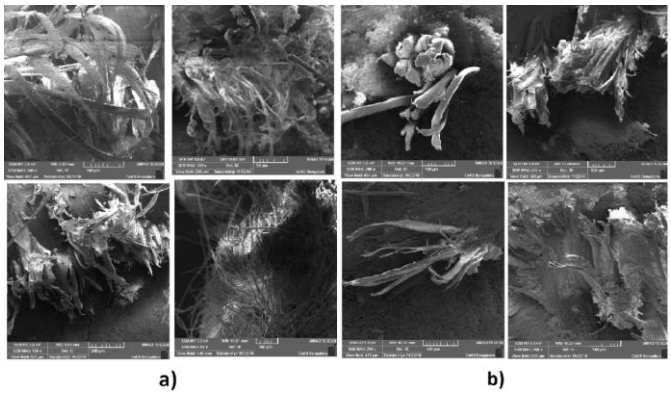

Figure 5. a) chorpy b) izod test specimens

In the above the test specimens named 128 is conducted FESEM analysis for both chorpy and izod test specimens at CENS Bangalore. In order to conduct the FESEM analysis, gold sputtering is done to get good visibility of the fiber layers. The figure.6 shows the microstructure of fiber layers for izod and chorpy specimens. The images are captured at different magnification.

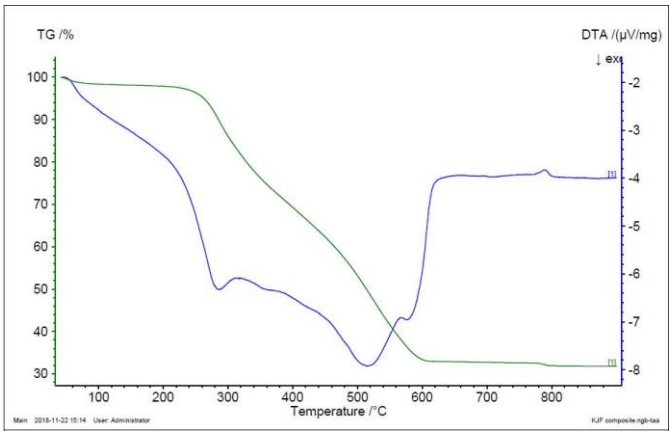

Figure 6. TGA/DTA graph

For this composite material thermo gravity analysis (TGA) and differential thermo analysis (DTA) is done to know the mass transfer at different stages of the temperature up to 900 ^{0}c. The TGA/DTA data is as shown in figure 6. In this the composite material powder is taken and it is kept under observation by increasing the temperature time to time at N2 (nitrogen) medium. From this data the composite material thermal properties and also the mass difference is observed with respect to the temperature. The percentage of mass transfer at different stages of temperature is observed on the graph as shown above figure 6.

VII.CONCLUSION

From the tensile and flexural tests we observe that the jute kevlar fiber reinforced composite material has good tensile and flexural strengths and the impact strengths of the composite material is increased with the more layers of jute fiber combination. The eight layers of jute with twelve layers of kevlar shows good impact strength in both chorpy and izod tests. In the FESEM the fiber layers has good strength and continues in manner at different magnifications. From the TGA/DTA data we observe that the material has good thermal properties and at high temperatures mass transfer variation is observed. Through this work we say that the usage of jute fiber in all kevlar applications will increase the strength of kevlar. By

reducing the usage of Kevlar we can reduce the cost also. So we can conclude that jute fiber can be used in all applications of kevlar mainly in the preparation of bulletproof vests, automobile bodies etc. in order to reduce the kevlar usage and the cost of the material.

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