Analysis of Mechanical Properties of Hybrid Composites Experimentally

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Abstract— *Due to increasing environmental concerns natural fibres are once again being considered as reinforcements for polymer composites. This present work evaluated the effect of mechanical properties of hybrid (carbon+flax) fibre reinforced epoxy composites. In this work hybrid (carbon+flax) fibre is used as reinforcement which treated with NaOH solution for enhancing the bonding strength between fibre and resin by removing moisture contents. Samples of hybrid (carbon+flax) fibre reinforced composites were fabricated by compression moulding and investigated their mechanical properties. The work of this experimental study has been carried out to determine the mechanical properties due to the effect of hybrid (carbon+flax) + carbon) fibre with orientations as $0^0/90^0$ orientation. The results of this study indicate the orientation $0^0/90^0$ gives better mechanical properties* when compared with the other orientations.

Keywords — *Orientations, Composite, Epoxy, Resin; Flax, Carbon, Testing.*

I. INTRODUCTION

Composite material is combination of two or more materials of distinguish property into a single material. Now a day the usage of composite has been increased in all industries especially in aerospace and automotive and automobile industries. The reasons behind usage of composite in those areas are its strength to weight ratio. Today industries are using maximally carbon fibre due to its inherent properties and its high mechanical strength. Three decades before material industry do not have much awareness about developing of carbon fibre but now situation has changed a lot. Usage of hybrid fibre is been quite increasing as technology development continuous.

In our case natural fibre is combined with synthetic fibre which leads to a new hybrid fibre. Combination of two or more a fibres of distinguished properties. These fibres are used to manufacture the body frame of sports car due to its low weight and high strength. For the sake of simplicity, however, composites can be grouped into categories. Based on the nature of the matrix each type possesses. Methods of Fabrication also vary according to physical and chemical properties of the Matrices and reinforcing fibres

II. OVER VIEW

Initially our projected started with literature survey and we decided to use natural fibre in our hybrid composite. The properties of flax fibre made us to use it in the hybrid composite. Next to this we have done the software analysis. We have performed software analysis using NASTRAN. The purchased fibre has been owned into cloth. Layers of fibre are compressed into a composite material. Various tests have been performed with fabricated composite material.

III. COMPOSITE BASED ON NATURAL FIBRES

Figure 1: Some of Brazilian Fibers (a) Banana Sheath, (b) Banana Fiber, (c) Coir, (d) Curaua, (e) Sponge Gourd, (f) Sisal, (g) Sugarcane Bagasse, (h) Ramie-Cotton fabric.

FIG.1 NATURAL FIBRES

The fibre that are extracted from natural material like wood stem, plant, flower, etc. are the natural fibres.

IV. FLAX

It is a member of the genus. It is a food and fibre crop that is cultivated in cooler regions of the world. Our hybrid composite is the combination of flax and carbon fibre. As per our there are some properties of flax is mentioned below.

TABLE I: MECHANICAL PROPERTIES OF FLAX

Quantity	Value	Unit
Young's modulus	50-70	GPa
Tensile strength	500-900	MPa

TABLE II: PHYSICAL PROPERTIES OF FLAX

Quantity	Value	Unit
Thermal conductivity	0.048 - 0.048	W/mK
Density	1.4-1.5	kg/m^3
Elongation	2.7	%

V. CARBON FIBRE

The atoms of carbon are bonded together into crystals which are parallel to the longitudinal axis of the fibre as the orientation and a angle place a major role in increasing the strength of carbon composites. As per our there are some properties of carbon fibre is mentioned below.

TABLE III: MECHANICAL PROPERTIES OF CARBON FIBRE

Quantity	Value	Unit
Young's modulus	70-80	GPa
Tensile strength	600-350	MPa
Poison ratio	0.77	

TABLE IV: PHYSICAL PROPERTIES OF CARBON FIBRE

Quantity	Value	Unit
Density	1.60	g/cc
Moisture absorption	0.03	%

VI. STRUCTURAL ANALYSIS

The structure analysis is dose with same NASTRAN. The structural analysis is nothing but it is about to analysis of the material characteristics. Such as stress, strain, load distribution and deformation of the structure.

In this structure analysis we calculated the following material properties for our composite material. The materials properties are:

- Total displacement
- Compressive strength
- Tensile strength
- Flexural strength

The following steps are carried out for our structural analysis:

- Applying the material property
- Meshing
- Load conditions
- Result by contour

VII. RESULT OF SOFTWARE ANALYSIS

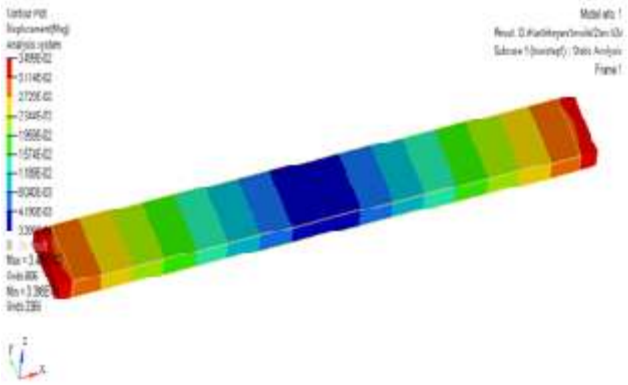

FIG.2 TENSILE STRESS RESULT FOR HYBRID COMPOSITE

The above picture reveals that the tensile stress is very high at its end points of the material where as the tensile stress level is much less comparatively

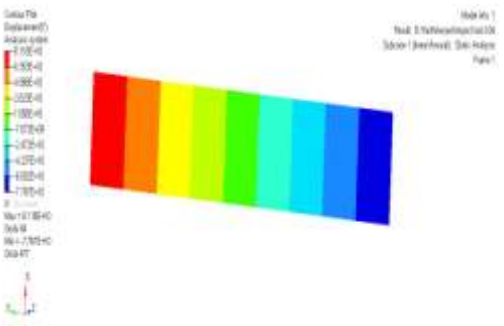

FIG.3 IMPACT STRENGTH RESULT FOR HYBRID COMPOSITE

The impact of the hybrid composite can be seen in the above figure. The impact value is high at the other end of the impact point.

VIII. FABRICATION PROCESS

Fabrication work started with the selection of material, Owning of fibre threads. The composite material component manufacturing is done by compression moulding technique.

- Material used:
- Flax fibre
- Carbon fibre
- Epoxy resin

A.METHOLOGY

1. Material selection (epoxy, flax)
2. Chemical treatment (alkali method, 5% NAOH)
3. Fabrication method (compression moulding)
4. Mechanical properties (tensile, impact, flexural)

FIG.4 COMPRESSION MOULDING PROCESS FOR HYBRID COMPOSITE

The layers of fibre are compressed with presence of epoxy resin into a composite material.

FIG.5 HYBRID COMPOSITE FABRICATE PLATE

IX. TESTING OF COMPOSITE

We have done few necessary test to determine our hybrid composite property.

A.TENSILE TEST

The hybrid composite material fabricated is cut into required dimension using a saw cutter and the edges finished by using emery paper for mechanical testing. The tensile test specimen is prepared according to the ASTM D638 standard. The dimensions, gauge length and cross-head speeds are chosen according to the ASTM D638 standard. A tensile test involves mounting the specimen in a machine and subjecting it to the tension. The testing process involves placing the test specimen in the testing machine and applying tension to it until it fractures. The tensile force is recorded as a function of the increase in gauge length. During the application of tension, the elongation of the gauge section is recorded against the applied force.

FIG.6 TENSILE TEST OF HYBRID COMPOSITE

B.FLEXURA TEST

The flexural specimens are prepared as per the ASTM D790 standard. The 3-point flexure test is the most common flexural test for composite materials. Specimen deflection is measured by the crosshead position. Test results include flexural strength and displacement. The testing process involves placing the test specimen in the universal testing machine and applying force to it until it fractures and breaks. The specimen used for conducting the flexural test . The tests are carried out at a condition of an average relative humidity of 50%

FIG.7 FLEXURA TEST OF HYBRID COMPOSITE

C.IMPACT TEST

The impact test specimens are prepared according to the required dimension following the ASTM-A370 standard. During the testing process, the specimen must be loaded in the testing machine and allows the pendulum until it fractures or breaks. Using the impact test, the energy needed to break the material can be measured easily and can be used to measure the toughness of the material and the yield strength.

FIG.8 IMPACT TEST OF HYBRID COMPOSITE

D.HARDNESS TEST

Hardness is the measure of how resistant solid matter is to various kinds of permanent shape change when a compressive force is applied. Some materials such as a metal are harder than others. Macroscopic of hardness is generally characteristics by strong intermolecular bonds, but the behaviour of solid materials under force is complex, therefore there are different measurements of hardness.

FIG.9 HARDNESS TEST OF HYBRID COMPOSITE

E.COMPRESSION TEST

It is the very basic and necessary test for material to determine the property and its strength.

FIG.10 COMPRESSION TEST OF HYBRID COMPOSITE

E.SCANNING ELECTRONIC MICROSCOPIC

The spread of crack or fracture during the process of testing can be clearly seen by SEM test.

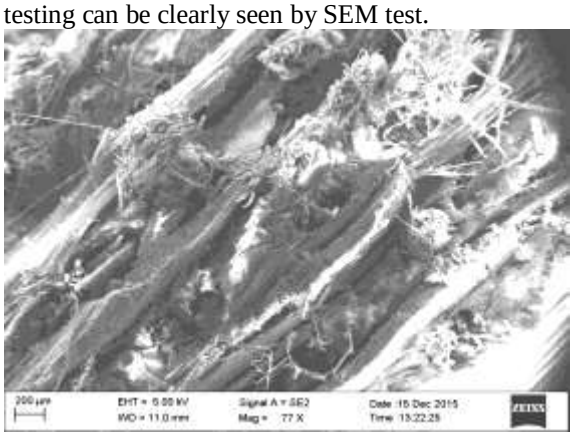

FIG.11SHOWS THE SEM MICROGRAPHS OF COMPRESSIVE FRACTURE SURFACE OF HYBRID REINFORCED EPOXY COMPOSITE

X. RESULT & DISCUSSION

TABLE V: RESULT OF TENSILE STRESS

S.NO	SPECIMEN	PEAK LOAD (N)	UTS(N/mm^2)
1	HYBRID	40000	125

The tensile test specimen is prepared according to the ASTM D3039 standard and the machine specifications are also chosen according to the ASTM D3039.According to the ASTM D3039 standard the dimensions of specimen used are 250x25mm. This test involves placing the specimen in a machine and subjecting it to the tension according to specific load until it fractures. . Table v shows the tensile test results for carbon fibre and hybrid reinforced composites. Among these the carbon fibre shows maximum tensile strength.

TABLE VI: RESULT OF FLEXURA TEST

S.NO	SPEIMEN	PEAK LOAD (N/mm)	FLUXERAL STRENGTH(Mpa)
1	HYBRID	716	65

Flexural test is also known as bending test and consists in applying a point load at the centre of composite material specimen. The flexural tests were done on the universal testing machine according to ASTMD790 with the crosshead speed of 10 mm/min. According to the ASTMD790 standard the dimensions of specimen used are 125x12.7mm. Table vi shows the flexural test results for different orientations of sisal fibre reinforced composites. Among these the 90^0 orientation shows maximum flexural strength.

TABLE VII: RESULT OF IMPACT TEST

S.NO	SPECIMEN	Impact strength(joules)
1	HYBRID	7.30

Impact test were carried out using izod impact test machine with specimen standard of ASTM A370.Generally carbon fibres possess good impact absorbing properties. The fracture values were calculated by dividing the energy by cross sectional area of the specimen. Table vii shows the impact test results for different orientations of carbon fibre and hybrid reinforced composites. The carbon fibre shows the maximum impact strength of 9.10 joules obtained.

TABLE VIII: RESULT OF COMPRESSION TEST

S.NO	SPECIMEN	UCS (N/mm)	ELONGATION (%)
2	Hybrid	355	0.3

The fabricated composite material with the ASTM D695 standard of has been compressed using the compression machine as shown above. The process of software analysis has been carried out in the NX NASTRAN and the distribution with the deviation of the composite is obtained.

XI. CONCLUSION

By fabricating the hybrid composite material a new evolution fibre has been started with this research project. The analysis of mechanical properties like tensile strength, compressive strength, and flexural strength had been carried out successfully, both practically and theoretically. Therefore the weight of the fibre is reduced successfully with considerable and acceptable reduction in strength of the composite material. And this reduction in the strength is due to the difference in the carbon layer in the hybrid and carbon composite material. This can be used in industrial area for construct the light weight structures.

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