ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Mechanical Characterization, Preparation and Comparison of Glass Fiber and Fiber Reinforcement with Aluminum Alloy (GFRAA) To Improve the Strengthening For Automotive and Aerospace Structural Applications

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ABSTRACT:

Fiber metal laminates are good candidates for advanced aerospace structural applications due to their high specific mechanical properties especially fatigue resistance. The most important factor in manufacturing of these laminates is the adhesive bonding between aluminum and FRP layers. In this study several glass-fiber reinforced laminates and glass –fiber reinforced with aluminum were manufactured. Mechanical Tests like Tensile, Compression and Impact tests were carried out based on ASTM standard were then conducted to study the strength of both the laminates under specific conditions and their resistance towards loads and impact behavior of these laminates are observed. In addition, FMLs of with good adhesion bonding show better resistance under low velocity impact and their corresponding contact forces are about 25% higher than that of specimens with a weak bonding. In this experiment we find that the tensile and impact strength of the glass fiber with Al is higher than the glass fiber alone. This result will produce the more fusible and dynamic properties in the composite structure. The strength of the glass fiber with al is more than the glass fiber laminate.

I. INRODUTION OF COMPOSITE MATERIAL

Basic requirements for the better performance efficiency of an aircraft are high strength, high stiffness and low weight. The conventional materials such as metals and alloys could satisfy these requirements only to a certain extent.

This lead to the need for developing new materials that can whose properties were superior to conventional metals and alloys, were developed. A composite is a structural material which consists of two or more constituents combined at a macroscopic level. The constituents of a composite material are a continuous phase called matrix and a discontinuous phase called reinforcement. In the highly competitive airline market, using composites is more efficient. Though the material cost may be higher, the reduction in the number of parts in an assembly and the savings in the fuel cost makes more profit. It also lowers the overall mass of the aircraft without reducing the strength and stiffness of its components.

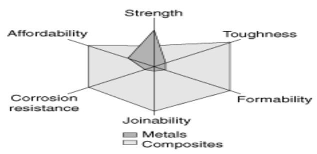

Figure 1.1 Primary Material Selection Parameter for a Hypothetical Situation for Metal and Composite

1.5.1 FIBER REINFORCED POLYMER (FRP)

The fiber reinforced composites are composed of fibers and a matrix. Fibers are the reinforcing elements and the main source of strength while matrix glues all the fibers together in shape and transfers stresses between the reinforcing fibers. Sometimes, filler is added to smoothen the manufacturing process and to impact special properties to the composites.

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These also reduces the production cost

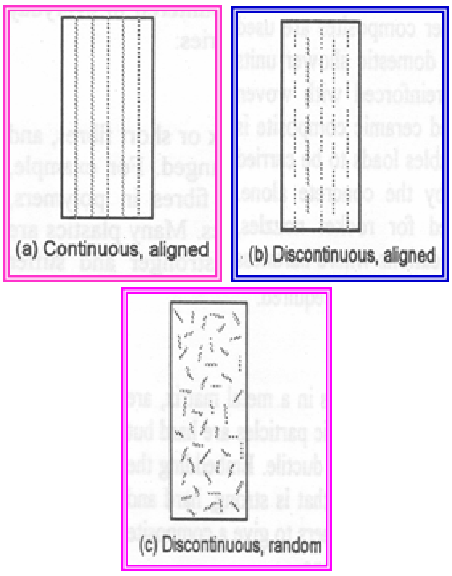

Figure 1.2 Types of Fiber Reinforced Polymer

METHODOLOGY:

The specimens were prepared with the glass fiber epoxy laminates with Aluminum alloy according to the ASTM standard. The specimens were undergoing for mechanical testing by Universal testing machine and Impact testing machine. These results were compared with and without aluminum alloy.

II. LITERATURE REVIEW

The purpose of this literature review is to provide background information on the issues to be considered in this thesis and to emphasize the relevance of the present study. This treatise embraces some related aspects of polymer composites with special reference to their mechanical property with aluminum.

TESTING:

In view of this, the present work is to investigate the mechanical properties like Tensile, Flexural (compression*) and Impact Strength of glass fiber epoxy laminate with and without Aluminum alloy.

TENSILE TEST

Tensile load applied to a composite. The response of a composite to tensile loads is very dependent on the tensile stiffness and strength properties of the reinforcement fibers, since these are far higher than the resin system on its own.Test was carried out with the help of UTM (Universal Testing Machine)

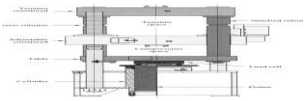

Figure. 7.1 Universal Testing Machine

III. REVIEW ON TENSILE TEST

This test is of static type i.e. the load is increased comparatively slowly from zero to a certain value. Standard specimens are used for the tension test. There are two types of standard specimen are which are generally used for this purpose, which have been shown below:

Specimen I & II:

Fig 7.2 Specimen of glass fiber laminate.

Fig 7.3 Specimen of glass fiber reinforced with alluminium

Fig 7.4 Tensile test being performed on universal testing machine.

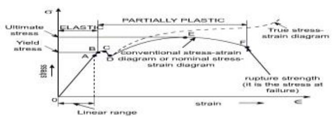

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Figure 7.5 stress strain curve

IV. IMPACT TEST

Impact test type charpy

Static tension tests of the unnotched specimen's do not always reveal the susceptibility of metal to brittle fracture. This important factor is determined in impact tests. In impact tests we use the notched specimen's

GRAPHS AND TEST RESULT

GFRP RESULT

TENSILE TESTING

Specimen 1

Ultimate tensile load (KN) : 24.65

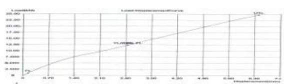
Ultimate tensile strength (MPa (or) N/mm^2) : 315

Gauge thickness (mm) : 3.08

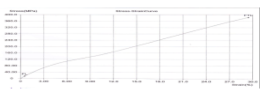
Gauge width (mm) : 25.37

Original Cross Sectional Area (mm^2) : 78.14

LOAD VS DISPLACEMENT GRAPH



STRESS VS STRAIN GRAPH



SPECIMEN 2

Ultimate tensile load (KN) : 29.00

Ultimate tensile strength (MPa (or) N/mm^2) : 347

Gauge thickness (mm) : 3.28

Gauge width (mm) : 25.48

Original Cross Sectional Area (mm^2) : 83.57

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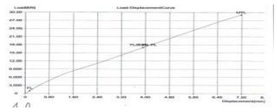
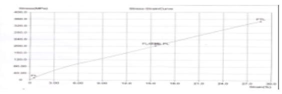


STRESS VS STRAIN GRAPH



COMPRESSION TEST *

Specimen 1

Compressive load (KN) : 1.23

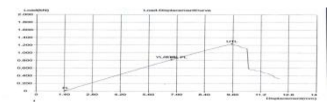
Compressive strength (MPa (or) N/mm^2) : 12

Gauge thickness (mm) : 3.86

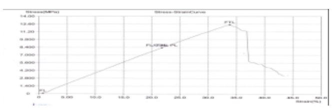
Gauge width (mm) : 25.53

Original Cross Sectional Area (mm^2) : 98.55

LOAD VS DISPLACEMENT



STRESS VS STRAIN GRAPH



Specimen 2

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Compressive load (KN)
: 1.19

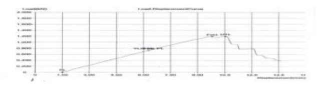
Ultimate tensile strength (MPa (or) N/mm^2) :
13

Gauge thickness (mm) :
3.71

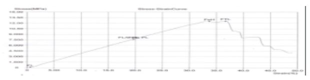
Gauge width (mm) :
25.50

Original Cross Sectional Area (mm^2) :
94.60

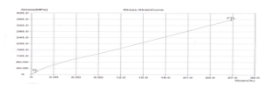
LOAD VS DISPLACEMENT



STRESS VS STRAIN GRAPH



STRESS VS STRAIN



Specimen 2

Ultimate tensile load (N)
: 26.37

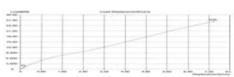
Ultimate tensile strength (MPa (or) N/mm^2) :
382

Gauge thickness (mm) :
2.72

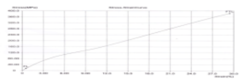
Gauge width (mm) :
25.38

Original Cross Sectional Area (mm^2) :
69.03

LOAD VS DISPLACEMENT



STRESS VS STRAIN



COMPRESSION TEST

Specimen 1

Compressive load (KN) :
0.94

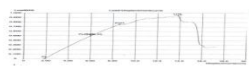
Compressive strength (MPa) :
11

Gauge thickness (mm) :
3.47

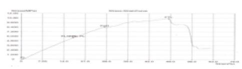
Gauge width (mm) :
25.64

Original Cross Sectional Area (mm^2) :
88.97

LOAD VS DISPLACEMENT



STRESS VS STRAIN



SPECIMEN 2

Compressive load (KN) :
1.00

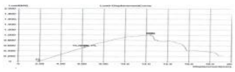
Compressive strength (MPa) :
11

Gauge thickness (mm) :
3.45

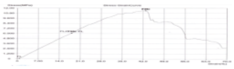
Gauge width (mm) :
25.47

Original Cross Sectional Area (mm^2) :
87.87

LOAD VS DISPLACEMENT



STRESS VS STRAIN



Test parameter	Sample 1	Sample 2	Sample 3	Average
Absorbed Energy-Joules	12	10	14	12

TABLE 7 GFRP-AL IMPACT TEST RESULTS

COMPARISON BETWEEN GFRP AND GFRP-Al

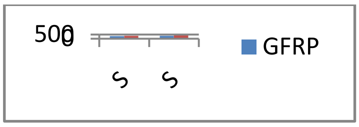
TENSILE TEST

	GFRP		GFRP-Al	
	Specimen 1	Specimen 2	Specimen 1	Specimen 2
Ultimate tensile load (KN)	24.65	29	25.82	26.37
Ultimate tensile strength (MPa)	315	347	355	382

TABLE 8 COMPARISION OF TENSILE TEST RESULTS
BETWEEN GFRP AND GFRP-AL

BAR GRAPH OF TENSILE TEST RESULTS

(GFRP VS GFRP-AL)



COMPRESSION TEST

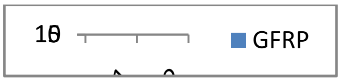
	GFRP		GFRP-Al	
	Specimen 1	Specimen 2	Specimen 1	Specimen 2
Compressive strength	12	13	11	11

TABLE 9 COMPARISION OF COMPRESSION TEST RESULT

BETWEEN GFRP AND GFRP-AL

BAR GRAPH OF COMPRESSION TEST RESULTS

(GFRP VS GFRP-AL)



IMPACT TEST

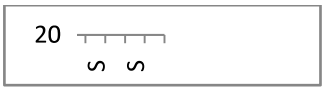
Test parameter	Absorbed energy	
	GFRP	GFRP-AL
Specimen 1	12	12
Specimen 2	10	10
Specimen 3	10	14
Average	10.67	12

TABLE 10 COMPARISION OF TENSILE TEST RESULT

BETWEEN GFRP AND GFRP-AL

BAR GRAPH OF TENSILE TEST RESULTS

(GFRP VS GFRP-AL)



V. CONCLUSION

From the obtained result we find that the tensile and impact strength of the glass fiber with Al is higher than the glass fiber alone. This will effect in the application like automobile, aeronautical and marine structures. This result will produce the more fusible and dynamic properties in the composite structure. The strength of the glass fiber with al is more than the glass fiber laminate.In the flexural strength of will not be increased during the reinforced the al with glass fiber, but during the testing the glass fiber with al specimen was not broken which cause the bending only. So that the elastic property will be high when compared to that of glass fiber alone. After releasing the load the glass fiber al specimen's was tried to regain to original level, which will increase the elastic property of the laminate. Also conclude that, even when increases the strength also will not effect on the actual weight and cost of the laminate since that al is lighter and cheaper.

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