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Mechanical Characterisation, Preperation and Comparision 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 aluminium 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.

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.

BASIC COMPOSITE THEORY

In recent times laminate composites have been increasingly utilized in such lightweight and high strength structured as ground transportation vehicles, aerospace and space structure. However composite material suffers from some serious limitation. The most significant among them is their response to impact loading. A structure is subjected to an impact force when a foreign object hits it. For instance, the loads imparted by dropped tool on the bonnet cover of

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car body, bird hit and runway debris on an aircraft engine are typical example of impact loads.

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.

Bearing strength of commingled boron/glass fiber reinforced aluminum laminates

Po-Ching Yen, The bearing properties of recently developed hybrid fiber/metal laminates, or Commingled Boron/glass fiber Reinforced Aluminum laminates (COBRA), are investigated in this study. The bolt-type bearing tests on Glass Reinforced aluminum laminates (GLARE) non-commingled hybrid boron/glass/aluminum fiber/metal laminates (HFML) and COBRA were carried out as a function of *e*/*D* ratio, metal volume fraction, fiber volume fraction, and fiber orientation. Experimental results show that with the same joint geometry and metal volume fraction, the commingling of boron fibers improves the bearing strength of fiber/metal laminates. Observations show the boron/glass fiber prepreg, transverse to the loading direction, results in a bearing mechanism that effectively increases the bearing strength. The bearing strength of COBRA with longitudinal fibers is lower than that with transverse fibers due to the fact that shear out failure takes place before maximum bearing strength is reached. The experimental results show that, with only either transverse fiber orientation or longitudinal fiber orientation, COBRA with 18% boron fiber volume fraction possesses a higher bearing strength when compared to HFML with 6% boron fiber volume fraction. In addition to the properties in COBRA with parallel-plies commingled prepreg, the bearing properties of various COBRA with [0°/90°] and [0°/90°/90°/0°] cross-ply commingled prepregs are also discussed.

LAMINATE MATERIALS AND METHODS

This chapter describes the materials and methods used for the processing of the composites under this investigation. It presents the details of the characterization and tests which the composite samples are subjected to.

GFRP LAMINATE

In this laminate, REINFORCEMENT - Glass Fiber Reinforcement Plastic (bi-directional type) E-glass.
MATRIX- Epoxy.
Correct ratio of resin and hardener is 10:1
Resin: LY556 Hardener: HY951

GLASS FIBER REINFORCEMENT PLASTIC

Glass is one of the oldest known man-made materials; the practical strength of glass, however, has always been a limiting and puzzling factor. Still today the mechanical properties of glass fibers are twofold a) a special quality is the high strength b) the brittle fracture is limiting its application. An understanding of the structure of glass in relation to how and why it breaks is crucial in both improving existing applications of glasses and in new functionalities and application of all kinds of glasses, not only fibre glass.

Fibers of glass are produced by extruding molten glass, at a temperature around 1200C through holes in a spinneret with diameter of 1 or 2 mm and then drawing the filaments to produce fibers having diameters usually between 5 to15µm

The fibers have low modulus but significantly higher stiffness Individual filaments are small in diameters, isotropic and very flexible as the diameter is small.
The glass fibers come in variety of forms based on silica (SiO_2) which is combined with other elements to create speciality glass.

III. CAR BUMPER OVERVIEW

INTRODUCTION

In automobiles, a bumper is usually a metal bar or beam, attached the vehicle's front-most and rear-most ends, designed to absorb impact in a collision.

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Regulations for automobile bumpers have been implemented to allow the car to sustain a low-speed impact without damage to the vehicle's safety systems. The main function of a bumper is to protect the car's body in a slight collision, typically at parking speed. The bumper structure on modern automobiles generally consists of a plastic cover over a reinforcement bar made of steel, aluminum, fiberglass composite, or plastic.

INDIA LAMINATE PREPERATION

This whole process of laminate preparation can be best explained by the series of pictures as shown ow.

Fig 6.1 Glass fiber sheet

A Glass fiber sheet according to our requirement is taken and care must be taken in handling the glass fiber as the fibers may stick to the clothes and causes irritation and other skin problems. So care must be taken while handling this glass fiber sheets and proper clothing should be used to avoid any issues to the skin.

Fig 6.2 and 6.3 Cutting of Glass fiber Sheets.

Glass fiber sheets are cut into the dimensions as our preferences. Here the sheets are Cut into 30 *30 cm and cut as many sheets as our requirement.

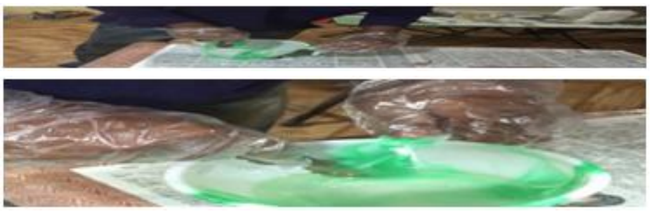

Fig 6.4 and 6.5 Mixing of resin and hardener

Resin and Hardener are used to bond the laminate fibers. These are mixed in the ratio of 10:1 respectively and make sure that both are mixed properly and must be used quickly in order to prevent the mixture from wasting.

Fig 6.6 Applying of the prepared solution to the fiber sheet.

The glass fiber sheets are taken and the solution is applied evenly all over the surface and other sheet is place over it and the same is done by attaching a total of 5 sheets to prepare a laminate. The solution must be applied thoroughly all over the sheets so as to obtain better laminates and care should be taken to avoiding the contact of the hands and other body parts.

Fig 6.7 Aluminium powder

For preparation of Glass fiber with aluminium the aluminium power of required quantity is taken and mixed in the solution of resin and hardener. Alluminium powder is kept in the solution and mixed thoroughly and this solution is used in the bonding of the laminates.

As the solution is mixed and applied evenly over the surface of the glass fiber sheets the alluminium also mixes well and combines with the glass fiber sheets through the pores present in the sheets and this mixture makes the glass fiber sheets reinforced with alluminium.

After completion of bonding of both the sheets i.e. glass fiber and glass fiber reinforced with aluminum, both these are subjected to heavy loads for better bonding and is left for 48 to 74 hours at room temperature.

After this time this sheets are taken and machined as per our taken dimensions and cut into pieces of required dimensions.

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Fig 6.8 Laminate of glass fiber

Fig 6.9 Laminate of glass fiber reinforced with aluminum.

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

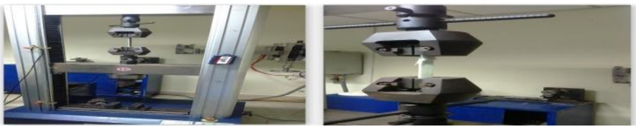


Fig 7.4 Tensile test being performed on universal testing machine.

GRAPHS AND TEST RESULT

GFRP RESULT

TENSILE TESTING

Specimen 1

Ultimate tensile load (KN) : 24.65

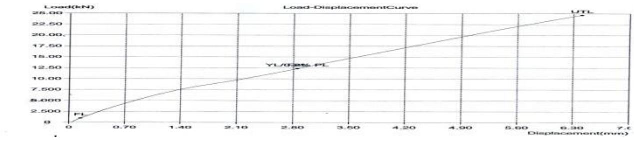
Ultimate tensile strength (MPa (or) N/mm^2) : 315

Gauge thickness (mm) : 3.08

Gauge width (mm) : 25.37

Original Cross Sectional Area (mm^2) : 78.14

LOAD VS DISPLACEMENT GRAPH



GFRP-AL RESULTS IN TABULAR FORM

Test Parameters	Sample ID: 1	Sample ID: 2
Gauge Thickness (mm)	2.85	2.72
Gauge Width (mm)	25.52	25.38
Original Cross Sectional Area (mm^2)	72.73	69.03
Ultimate Tensile Load (kN)	25.82	26.37
Ultimate Tensile Strength (MPa (or) N/mm^2)	355	382

TABLE 5 GFRP-AL TENSILE TEST RESULTS

Test Parameters	Sample ID: 1	Sample ID: 2
Gauge Thickness (mm)	3.47	3.45
Gauge Width (mm)	25.64	25.47
Original Cross Sectional Area (mm^2)	88.97	87.87
Compressive Load (kN)	0.94	1.00
Compressive Strength (MPa (or) N/mm^2)	11	11

TABLE 6 GFRP-AL COMPRESSION TEST RESULTS

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

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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

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

Future Scope:

In this regard the laminate will prepare according to study the thermal characterization and mechanical characterization. FMLs consist of metallic alloy and fiber reinforced prepreg. Mostly commercially available GLARE, ARALL and CARALL consist various aluminium alloys. Many researchers have been trying to use possible metallic alloys such as magnesium, titanium, etc. instead of aluminium alloys. It is expected that this diversity gives optimum mechanical properties. Same efforts have been examined for engineering polymeric materials to replace fiber reinforced prepreg.

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.

REFERENCES

[1]H.S.Park, X.P.Dang, A.Roderburg, “Development of Plastic Front Panels of Green Cars” CIRPJournal of Manufacturing & Technology vol 26 Pages 35-53

[2]Kuziak.R.Kawalla, R.waengler.s. “Advanced high strength materials for automotive industry A review” Journal of Archives of Civil & Mechanical engineering .volume 8 issue2, 2008-12-30 ,Pages 103-117

[3]Falai Chen, Bert Juttler, “Geometric Modeling & Processing”, Journal on CAD, volume 42 issue1 pages1-15

[4]David H. Allen “Structural Analysis, Aerospace” Journal on Encyclopedia of Physical science and technology 3rd edition 2003

[5]Japan.s.Daniel.L. and Theodor .k.2005. “Finite Element Analysis of Beams”, Journal of Impact engg.Vol31, Pages 861-876., Pages155-173.

[6]OLBISIolagoke (1997) “Hand book of Thermo Plastics”, Marcel Dekker, New York.

[8]Dominick v. rosato, “Plastics Engineering”, Manufacturing & Data Hand Boo