IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 68-73

Design And Analysis of Bumper

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Abstract: *Glass fiber reinforcement has been a recent trend and effective method for enhancing strength characteristic of metals, plastics, joints etc. at a very low competitive cost. Aluminum is a light weight metal with less strength characteristic as compared to other metals. Comparative analysis is made between aluminum and glass fiber reinforced aluminum specimen for studying strength properties. A nonlinear material approach is used for simulation. Experimental analysis will be done with help of three-point bending test. Force plots are used for comparing both models. FEA and experimental results will be validated by comparative analysis. Result and conclusion will be stated after the comparative analysis between FEA & Experimental testing.*

Keywords: *Aluminium, Aluminium Glass Fiber Reinforcement, FEA, Three Point Bending Test, Result*

I. Introduction

World is now focused on the rapid developments in the various fields such as aerospace, space, automotive, electronics, and defense, infrastructure developments & power generation. Automotive sector has emerged as booster to the economy of nations over worldwide. As automotive manufactures are looking to bring light weight and fuel-efficient vehicles in market. So, there is continual research on reducing the cost of vehicle by utilizing the light weight composites which can give similar mechanical characteristics as compared to metals parts used in automobile.

Current research work focuses on use of aluminum and glass fiber composite to be utilized in manufacturing of bumpers of automobiles. It is anticipated that this aluminum glass fiber composite can absorb the lateral or transverse loading occurred during accidents or deliberately happed incidents. In this work 3-point bending approach is used to analyze the performance of composite material and compared with the aluminum Specimen. FEA method is used for modeling and simulation. Also, the FEA results are validated with experimental results. Aluminium - glass fiber reinforced plastics (GFRP) sandwich panels are hybrid laminates consisting of GFRP bonded with thin aluminum sheets on either side. Such sandwich materials are increasingly used in airplane and automobile structures. Laminates with varying aluminium thickness fractions, fiber volume fractions and orientation in the layers of GFRP were fabricated by hand layup method and evaluated for their impact performance by conducting drop weight tests under low velocity impacts. The impact energy required for initiating a crack in the outer aluminium layer as well as the energy required for perforation was recorded. The impact load-time history was also recorded to understand the failure behavior. The damage depth and the damage area were measured to evaluate the impact resistance. Optical photography and scanning electron micrographs were taken to visualize the crack and the damage zone. The bidirectional cross-ply hybrid laminate (CPHL) has been found to exhibit better impact performance and damage resistance than the unidirectional hybrid laminate (UDHL). Increase in aluminium thickness fraction (Altf) and fiber volume fraction (Vf) resulted in an increase in the impact energy required for cracking and perforation. On an overall basis, the sandwich panels exhibited better impact performance than the monolithic aluminium.

The composite materials are used in many engineering applications due to their excellent properties. The sandwich composite materials replace the metals owing to their excellent strength with low weight. Many of the literature deals with the combination of steel or aluminium reinforced with the glass fiber reinforced composites materials (GFRP). The carbon fiber finds application in aerospace and related fields. The cost of fabrication is reduced by using sandwich structures. The aluminium is sandwiched between the carbon layers formed as fiber metal laminates (FML), and it has excellent qualities such as overall reduced weight, corrosion resistance and environment friendly. Along with the host of benefits, the main disadvantage is the fabrication of these composites which is difficult1. The aircraft materials are developed based on fiber metal laminates which needs the improved crack growth properties. Competing materials like advanced aluminium alloys and fibre reinforced composites have potential to increase the cost effectiveness of the structure. Fibre metal laminates (FMLs) have hybrid composite structures based on thin sheets of metal alloys and plies of fibre reinforced polymeric materials.

II. Problem Statement

To find out the performance of aluminum glass fiber composite specimen subjected to three point bending conditions.

III. Objectives

Non-Linear analysis of Aluminium Specimen and Aluminium Glass Fibre Composite Specimen.

- Experimental study of Aluminium Specimen and Aluminium Glass fibre Composite Specimen.
- Find bending loads and stress plots.
- Find the deformation plots with respect to loads.

IV. Methodology

From the literature it is learned that how 3D CAD model is to be prepared. The conditions required for applying various constraints and how the loads are applied is briefed in the technical papers referred.

- 3D CAD Model Generation
  - Getting input data on dimensions of Aluminum Specimen
  - Creating 3D model in CATIA.
- Determination of loads
- Determination of different loads and boundary condition acting on the component by studying various reference papers and resources available
- Testing and Analysis
  - Meshing the CAD model and applying the boundary conditions.
  - Solve for the solution of meshed model using ANSYS.
- Fabrication, Experimental validation and Result Analysis
  - Fabrication of specimen
  - Suitable experimentation
  - Validation of result by comparing with software results.

V. Catia

CATIA (computer aided three-dimensional interactive application) is a multi – platform computer - aided design (CAD) / computer - aided manufacturing (CAM) / computer - aided engineering (CAE) software suite developed by the French company Dassault Systems. CATIA delivers the unique ability not only to model any product, but to do so in the context of its real-life behavior: design in the age of experience. Systems architects, engineers, designers and all contributors can define, imagine and shape the connected world.3D CAD modeling of the Aluminium Specimen is made using software CATIA V5

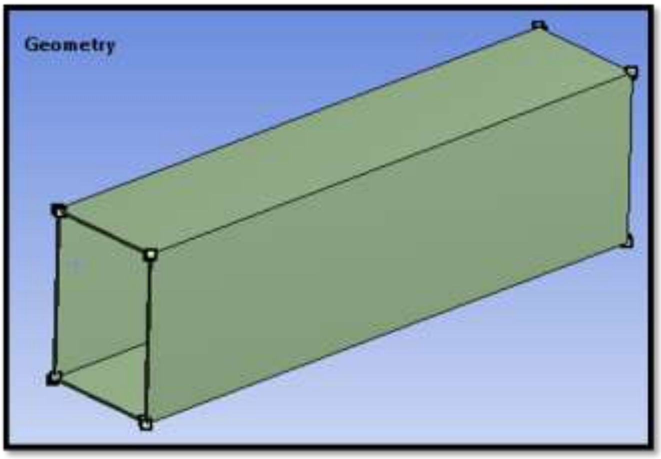


Fig.1 CATIA of Aluminium Specimen

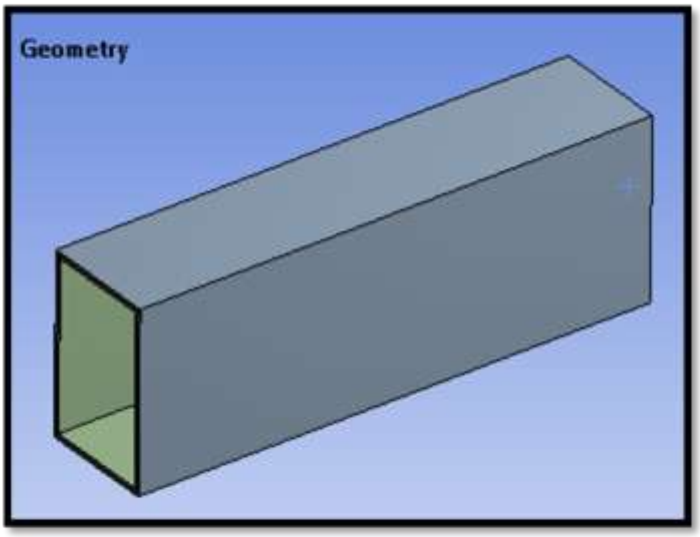


Fig. 2 CATIA of Aluminium Glass Fibre Specimen

VI. Analysis

The Finite Element Method is a numerical approximation method, in which the complex structure is divided into number of small parts that is pieces and these small parts are called as finite elements. These small elements are connected to each other by means of small points called as nodes. As the finite element method uses matrix algebra to solve the simultaneous equations, so it is also known as structural analysis and it's becoming primary analysis tool for designers and analysts.

Meshing:

ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient Multiphysics solutions. A mesh well suited for a specific analysis can be generated with a single mouse click for all parts in a model. Full controls over the options used to generate the mesh are available for the expert user who wants to fine-tune it. The power of parallel processing is automatically used to reduce the time you have to wait for mesh generation.

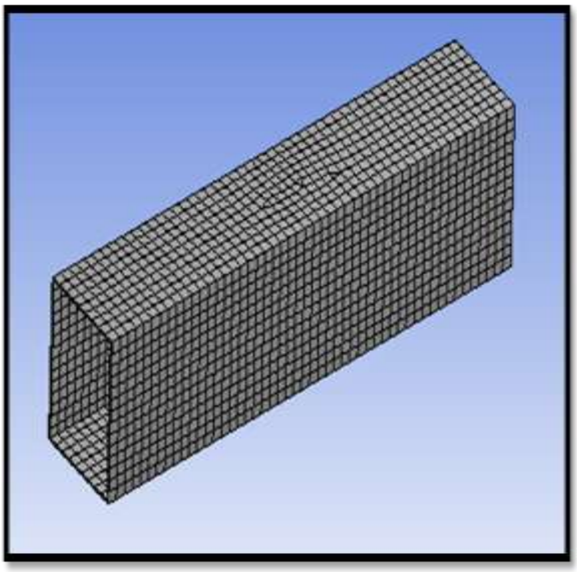


Fig.3 Meshing of Aluminium Specimen

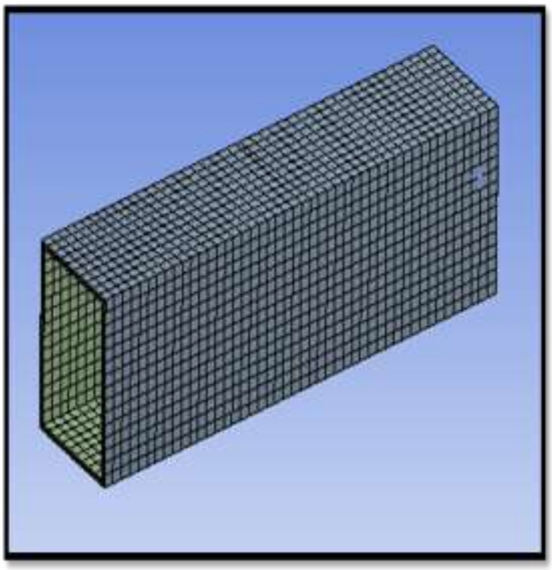


Fig. 4 Meshing of Aluminium Glass Fibre

Boundary Condition:

A boundary condition for the model is the setting of a known value for a displacement or an associated load. For a particular node you can set either the load or the displacement but not both.

The main types of loading available in FEA include force, pressure and temperature. These can be applied to points, surfaces, edges, nodes and elements or remotely offset from a feature. The way that the model is constrained can significantly affect the results and requires special consideration. Over or under constrained models can give stress that is so inaccurate that it is worthless to the engineer. In an ideal world we could have massive assemblies of components all connected to each other with contact elements but this is beyond the budget and resource of most people. We can however, use the computing hardware we have available to its full potential and this means understanding how to apply realistic boundary conditions.

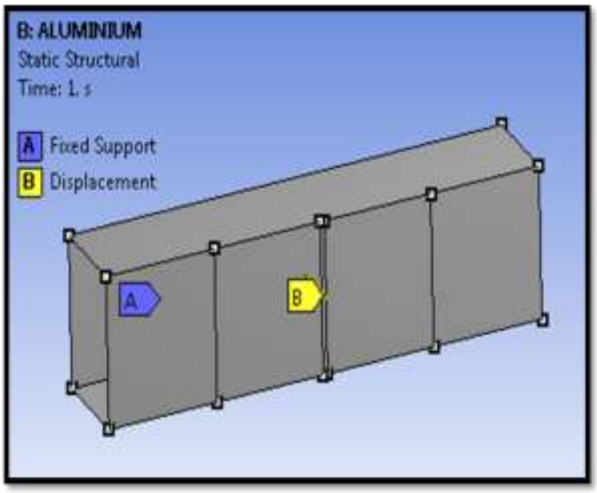


Fig. 5 Boundary Condition of Aluminium

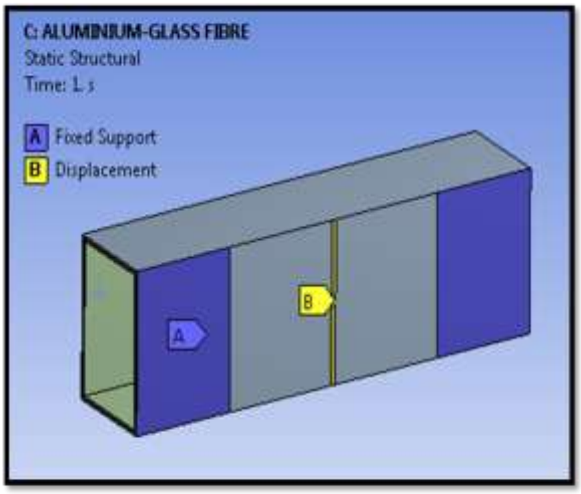


Fig.6 Boundary Condition of Aluminium Glass Fibre

Total Deformation:

The total deformation & directional deformation are general terms in finite element methods irrespective of software being used.

Directional deformation can be put as the displacement of the system in a particular axis or user defined direction.

Total deformation is the vector sum all directional displacements of the systems.

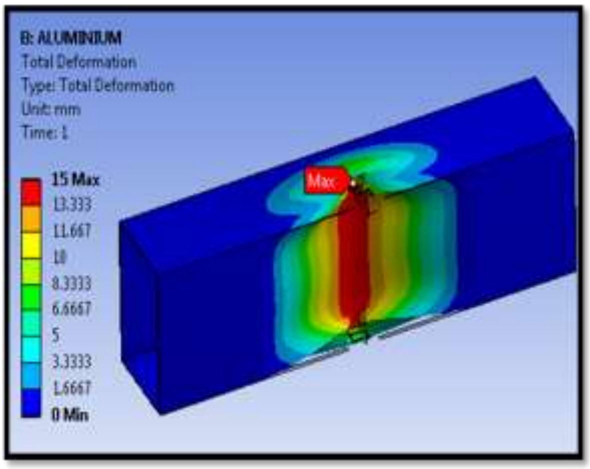


Fig. 7 Total Deformation of Aluminium

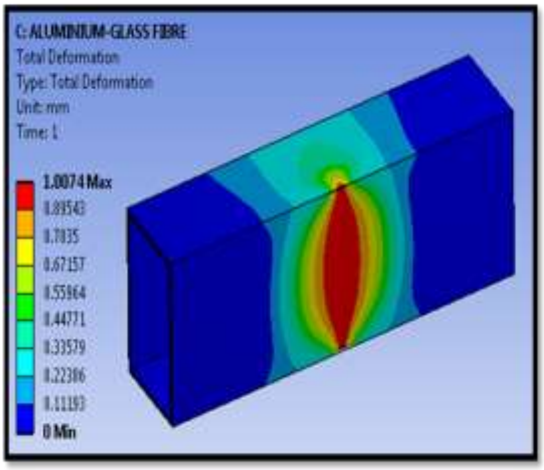
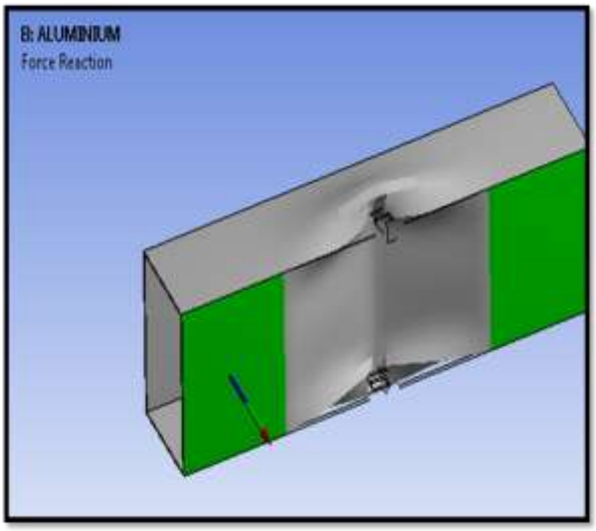
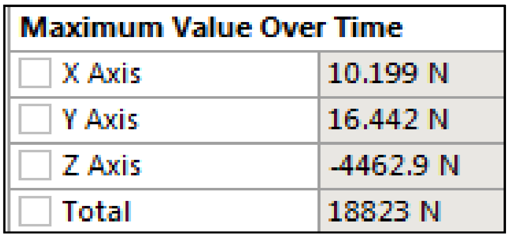


Fig. 8 Total Deformation of Aluminium Glass fibre

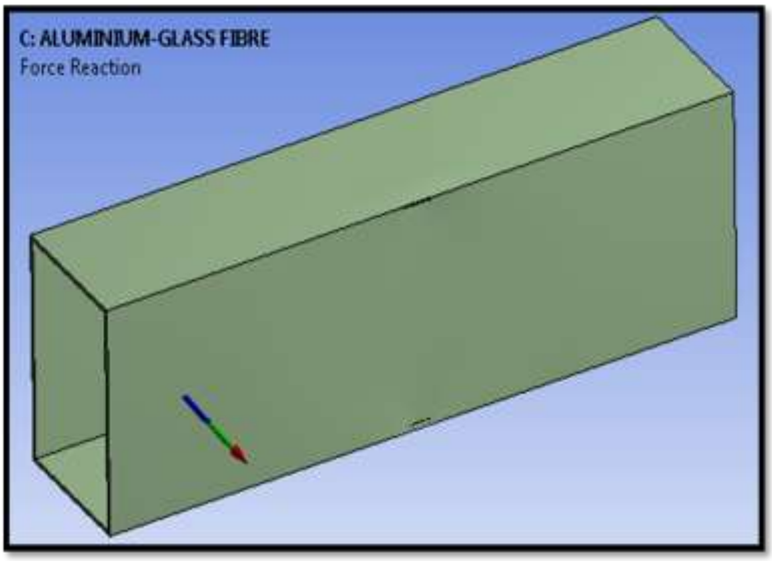
Reaction Forces:

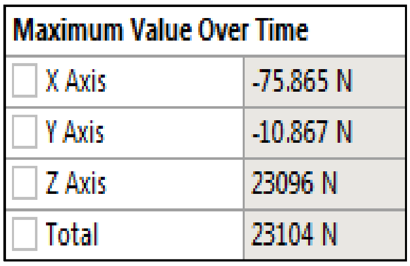




Maximum Value Over Time	
☐ X Axis	10.199 N
☐ Y Axis	16.442 N
☐ Z Axis	-4462.9 N
☐ Total	18823 N

Fig.9 Reaction Forces of Aluminium





Maximum Value Over Time	
☐ X Axis	-75.865 N
☐ Y Axis	-10.867 N
☐ Z Axis	23096 N
☐ Total	23104 N

Fig. 10 Reaction Forces of Aluminium Glass Fibre

VII. Result

Characteristics	Aluminium specimen	Aluminium glass fiber specimen
Equivalent stress	253.12 MPa	234.85 Mpa
Density	2703 kg/m^3	4703 kg/m^3
Mass	2.75 Kg	4.45 Kg
Volume	1.02 e-3 m^3	1.02 e-3 m^3
Reaction force	73272 N	2.137e+005 N

VIII. Conclusion

From the current research the following results were made.

1. The reinforced glass epoxy composites gives higher bending strength due to strong adhesion of aluminum surfaces with epoxy resin
2. Reaction force for aluminum is less as compared with Aluminium Glass fibre Composite.
3. Effect of glass fiber and different metals could be analyzed as a future work for enhancing mechanical properties.

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