

Experimental and Numerical Analysis of Front Car 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. Aluminium is a light weight metal with less strength characteristic as compared to other metals. Comparative analysis is made between aluminium and glass fibre reinforced aluminium 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 are going to be stated after the comparative analysis between FEA & Experimental testing.

Key words- Glass Fibre reinforcement, Aluminium, Three-point bending test, FEA & Experimental testing.

I. Introduction

World is now focused on the rapid developments in the various fields such as aerospace, space, automotive, electronics, and defence, 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 [1].

The fibre/metal composite technology combines the benefits of metallic materials and fibre reinforced matrix systems. Metals are isotropic because they have a high bearing strength and impact resistance and are easy to repair. Full composites have a superb fatigue characteristic and have high strength and stiffness. The fatigue and corrosion characteristics of metals and therefore the low bearing strength, impact resistance and reparability of composites have overcome by the mixture of metal and fibers [2,3]. These material systems are created by bonding composite laminate plies to metal plies. The concept is usually applied to aluminium with aramid and glass fibres, also it is applied to other constituents. Several articles have shown that, FMLs possess both the wonderful impact resistance characteristics of metals and the attractive mechanical properties of fibre reinforced composite materials [4].

A. Components of Bumper

Bumpers in cars are meant for absorbing shock or impact at low velocity like accidentally hitting while reversing the car. A urethane or other flexible polyethylene plastic bumper cover is applied to the surface to offer the car a finished appearance.

Modern bumpers are made with a mixture of materials. The first element is an impression absorbing spring device, usually gas-filled cartridges which mount the front bumper to the chassis. This allows the bumper system to soak up minor impacts with none damage.

The bumper system is usually recognized as being comprised of 4 basic components namely bumper fascia, energy absorber, bumper beam and bumper [6].

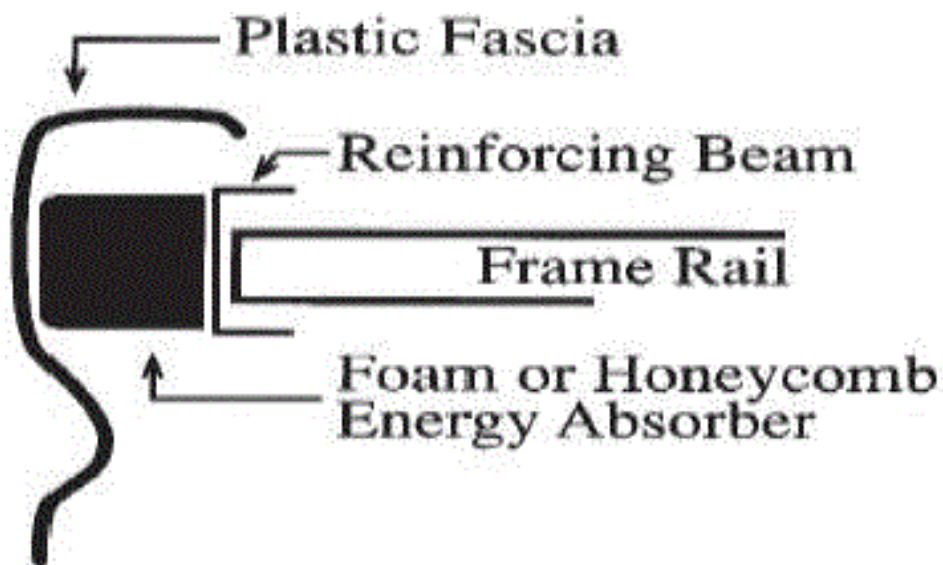


Fig.1. Basic Component of Bumper

- 1) **Fascia:** bumper fascia must be aerodynamic, light weight and aesthetically pleasing to the consumer. Usually fascia is made of polypropylene, polyurethane or polycarbonate.
- 2) **Energy absorbers:** energy absorbers are designed to negotiate a portion of the kinetic energy from vehicle Collision.
- 3) **Reinforcing beam:** this part is a key component of the bumper and helps absorb the kinetic energy and serve protection to the rest of the vehicle and passengers [5,6].

II. Methodology

From lots of literature studies and after various experiments the proper method to find the result of aluminium Glass fibre reinforcement with various tests are as follows:

- 3D CAD Model Generation
- Determination of loads
- Testing and Analysis
- Fabrication, Experimental validation and Result Analysis

III. Design of Catia Model

A. Aluminium without Glass Fibre reinforcement:

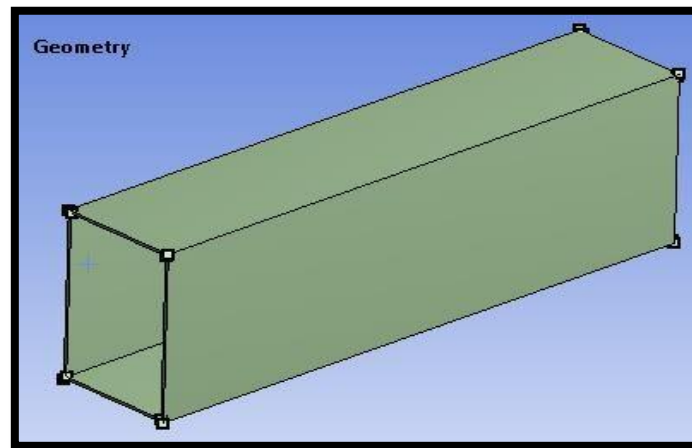


Fig.2. CATIA model of Aluminium specimen

B. Aluminium with Glass Fibre Reinforcement:

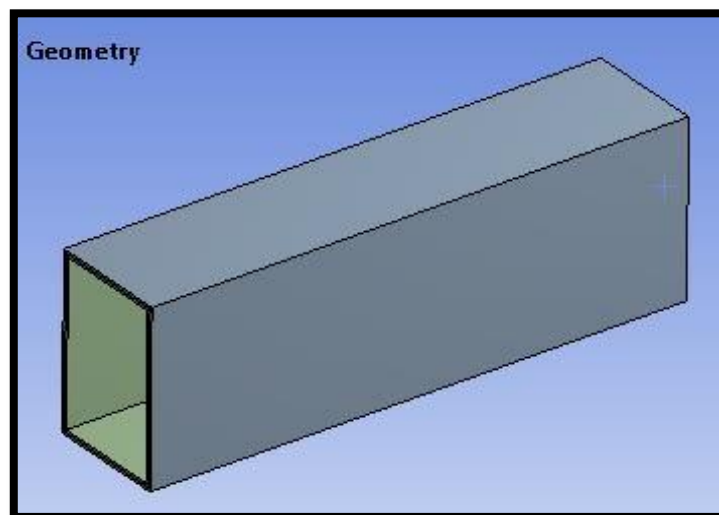


Fig.3. Aluminium Specimen with 2mm Glass fibre reinforcement

IV. FEA Analysis of Specimen

A. Aluminium Specimen:

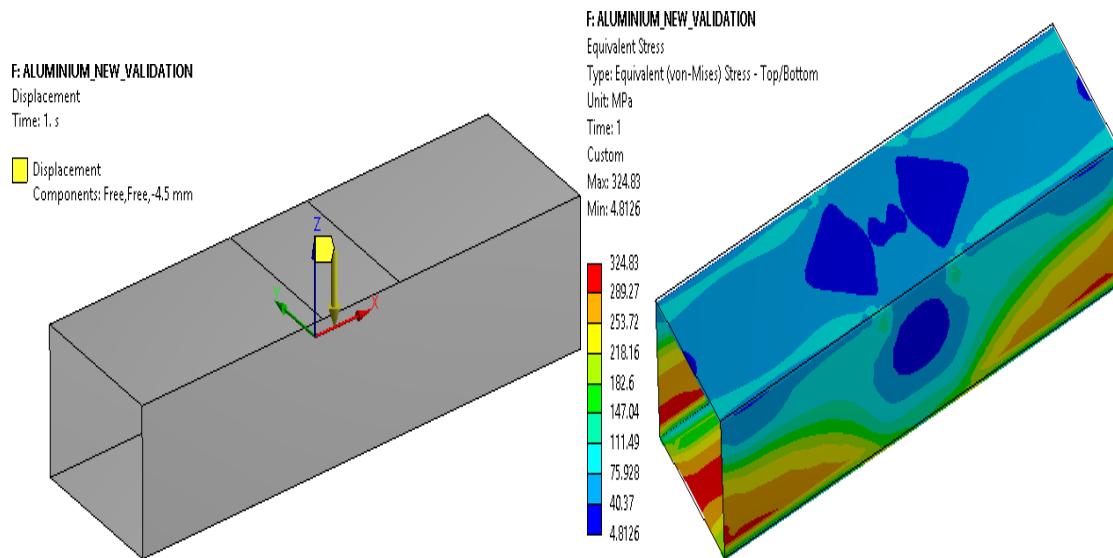


Fig.4.FEA analysis showing deformation and stress Analysis.

Details of "Displacement"	
[-] Scope	
Scoping Method	Geometry Selection
Geometry	1 Face
[-] Definition	
ID (Beta)	30
Type	Displacement
Define By	Components
Coordinate System	Global Coordinate System
X Component	Free
Y Component	Free
☐ Z Component	-4.5 mm (ramped)
Suppressed	No

Table No.1. Details of Displacement Analysis.

Maximum Value Over Time	
☐ X Axis	0.10146 N
☐ Y Axis	1.5201 N
☐ Z Axis	3245.4 N
☐ Total	3245.4 N

Table No.2.Details of Reaction forces acting of component.

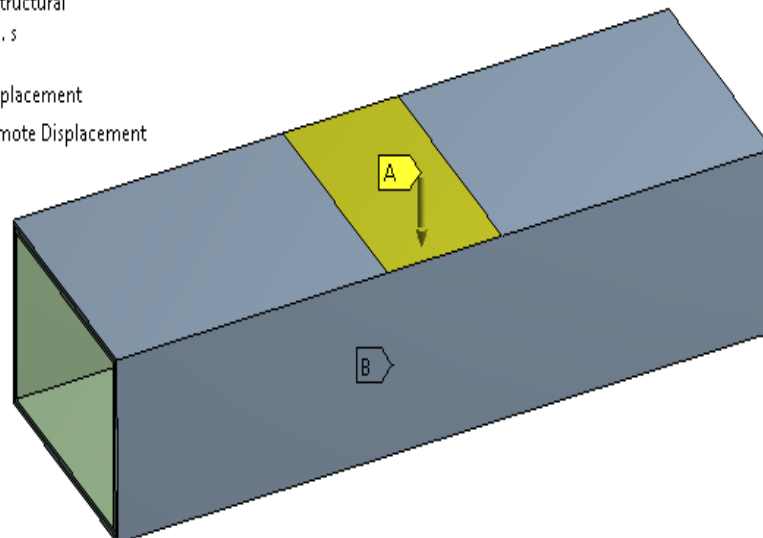
B. Aluminium R

F: ALUMINIUM-GLASS FIBRE VALIDATION

Static Structural

Time: 1. s

- A** Displacement
- B** Remote Displacement



F: ALUMINIUM-GLASS FIBRE VALIDATION

Equivalent Stress

Type: Equivalent (von-Mises) Stress

Unit: MPa

Time: 1

Custom

Max: 1124.9

Min: 0.26078

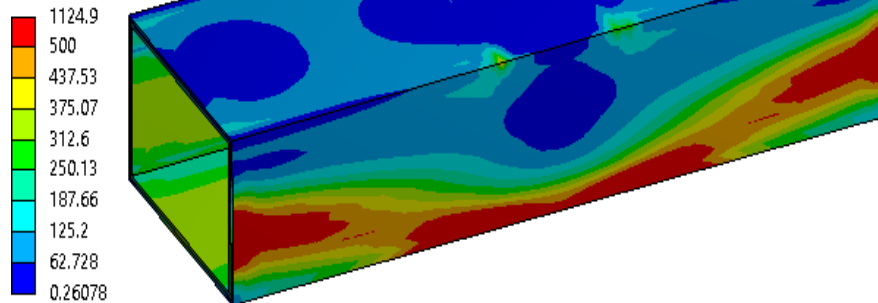


Fig.4. FEA analysis showing Displacement and Stress Analysis.

Details of "Displacement"	
[-] Scope	
Scoping Method	Geometry Selection
Geometry	1 Face
[-] Definition	
ID (Beta)	30
Type	Displacement
Define By	Components
Coordinate System	Global Coordinate System
☐ X Component	0. mm (ramped)
☐ Y Component	0. mm (ramped)
☐ Z Component	14. mm (ramped)
Suppressed	No

Table No.3. Details of Displacement.

Maximum Value Over Time	
☐ X Axis	55.947 N
☐ Y Axis	17.416 N
☐ Z Axis	-3644.3 N
☐ Total	14866 N

Table No. 4. Details of Reaction forces acting on component.

1.Comparison of Result Obtained from FEA:

From Analysis we are came to know that reaction force for Aluminium specimen for 4.5mm displacement is 3245.4N and same for composite specimen having 14mm displacement is 14866N. i.e. by doing some basic calculations we had reached to the result that Reaction force for Composite Specimen is increases **48%**.

V. Conclusion

The Composite specimen has more stronger and more beneficial properties which will enhance the bumper specimen and will take it to the next level. From Analysis we are upto the result that reaction force in composite specimen is more than the Aluminium specimen i.e more resistance will be offered by composite specimen to the impact imposed on the bumper due to many reasons such as accidents, unexpected dash and many more. So it is more beneficial and safe to use the Bumper made from composite specimen rather than only metal such as Aluminium as it will ensure more safety to passengers inside the vehicle [5,6].

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