IDENTIFICATION AND ANALYSIS OF COMPOSITE MATERIALS FOR BUMPER BEAM

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Abstract
The aim of this study is to analyze fabricated bumper of GFRP material with steel. GFRP bumper is reinforced with epoxy resin in order to reduce weight and increasing further strength. This bumper absorbs the impact with its deformation and transfers perpendicularly to the impact direction. Glass fiber reinforcements have mostly enhanced impact and tensile properties, marginal improvement of tensile strength has led the researchers to investigate further finding of better material for bumper. Ample attempts have been made towards improving mechanical properties, with efforts oriented at improving the interface, newer methods of production of composites and new modeling techniques etc. The laminate and specimen were fabricated by GFRP with natural fibre as constituent. Experimental investigation was done on the fabricated GFRP bumper. Theoretical stress analysis was done for GFRP, CFRP and steel bumper was the results were compared.

Keywords: *Bumper, GFRP, CFRP, Glass Epoxy*

1. Introduction

A bumper is a shield made of steel, aluminum, rubber, or plastic that is mounted on the front and rear of a passenger car. When a low speed collision occurs, the bumper system absorbs the shock to prevent or reduce damage to the car. In existing bumper the weight is more. In the present trends the weight reduction has been the main focus of automobile manufacturers. Less fuel consumption, less weight, effective utilization of natural resources is main focus of automobile manufacturers in the present scenario. The above can be achieved by introducing better design concept, better material and effective manufacturing process. Steel bumper have many advantages such as good load carrying capacity. In spite of its advantages, it stays back in low strength to weight ratio. It is reported that weight reduction with adequate improvement of mechanical properties has made composites as a viable replacement material for conventional steel. In the present work, the steel bumper used in passenger vehicles is replaced with a composite bumper made of glass/epoxy composites. The thickness of the composite bumper is calculated by bending moment equation and other dimensions for both steel and composite bumper is considered to be the same. The objective was to compare the stress, weight, and cost savings.

2. Material Design And Analysis

CATIA MODEL OF BUMPER BEAM

DIMENSIONS AND PROPERTIES OF EXISTING STEEL BUMPER:

Effective length = 0.975m
Total length = 2.055m
Thickness = 0.002m
Effective breath = 0.078m
Total breath = 0.172m
Weight = 5.16kg
Material = mild steel (chromium coated)
Tensile strength = 460MPa (design data book)
Density = 7800 kg/m

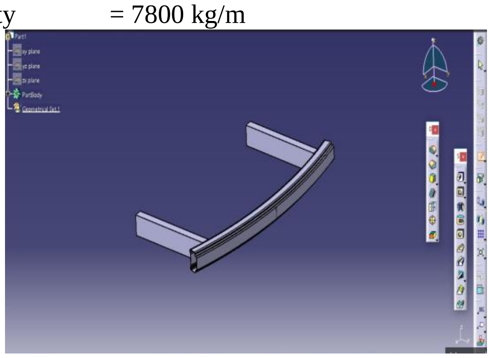


Figure 1 CATIA model of bumper beam

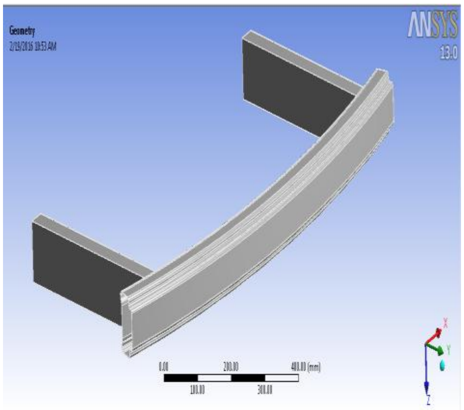


Figure 2 Geometry of bumper beam in ANSYS

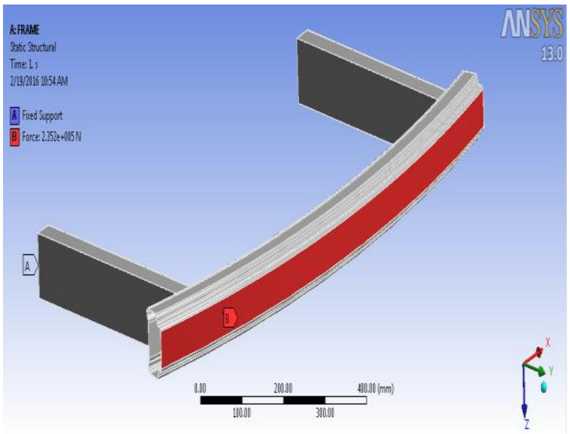


Figure 3 Boundary conditions of bumper beam in ANSYS

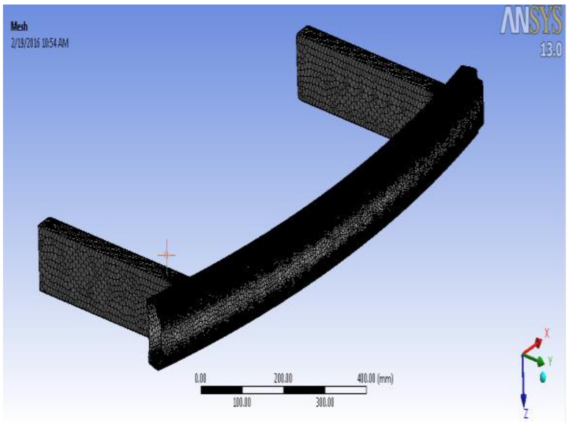


Figure 4 Meshing of bumper beam in ANSYS

Table 1 properties of steel used for ANSYS

Properties of Outline Row 5: Structural Steel

	A	B	C	D	E
1	Property	Value	Unit		
2	Density	7850	kg m^-3		
3	Isotropic Secant Coefficient of Thermal Expansion				
6	Isotropic Elasticity				
7	Derive from	Young's M...			
8	Young's Modulus	2E+11	Pa		
9	Poisson's Ratio	0.3			
10	Bulk Modulus	1.6667E+11	Pa		
11	Shear Modulus	7.6923E+10	Pa		

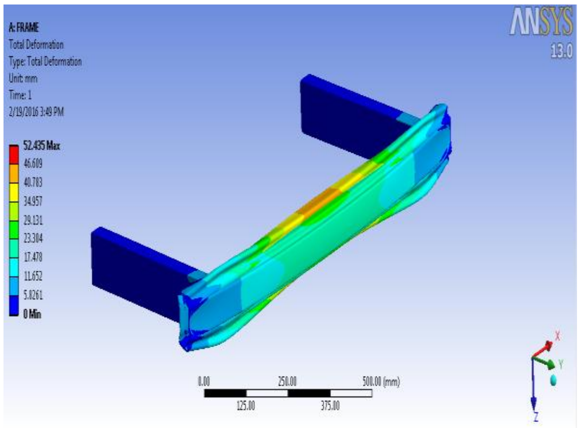


Figure 5 Total deformation of steel from ANSYS

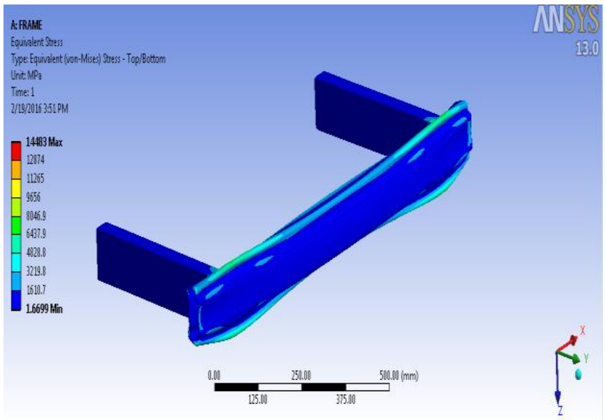


Figure 6 von mises stress for steel from ANSYS

Table 2 properties of CFRP used for ANSYS

Properties of Outline Row 3: CARBON FIBERS

	A	B	C	D	E
1	Property	Value	Unit		
2	Density	1500	kg m^-3		
3	Isotropic Elasticity				
4	Derive from	Young's M...			
5	Young's Modulus	1.5E+09	Pa		
6	Poisson's Ratio	0.28			
7	Bulk Modulus	1.1364E+09	Pa		
8	Shear Modulus	5.8594E+08	Pa		

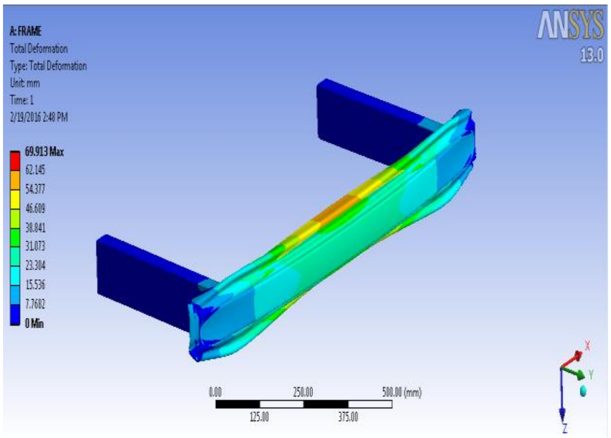


Figure 7 Total deformation of CFRP by ANSYS

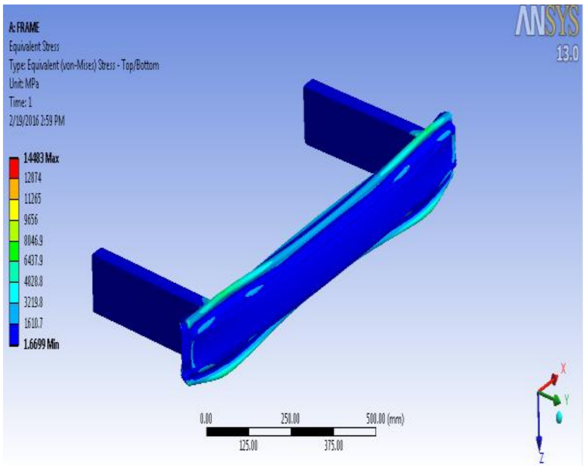


Figure 8 von mises stress for CFRP from ANSYS

Table 3 Properties of GFRP used for ANSYS

	A	B	C	D	E
1	Property	Value	Unit		
2	Density	1800	kg m^-3		
3	Isotropic Elasticity				
4	Derive from	Young's M...			
5	Young's Modulus	2.6E+10	Pa		
6	Poisson's Ratio	0.28			
7	Bulk Modulus	1.9697E+10	Pa		
8	Shear Modulus	1.0156E+10	Pa		

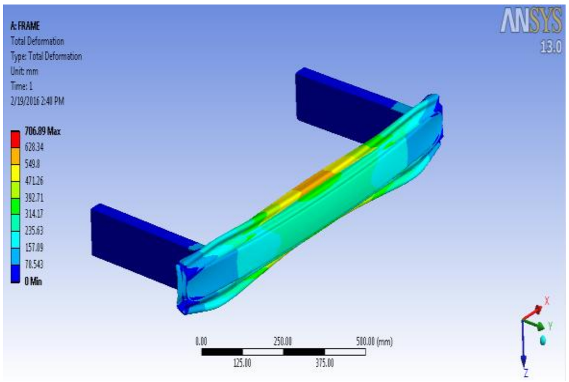


Figure 9 Total deformation of GFRP by ANSYS

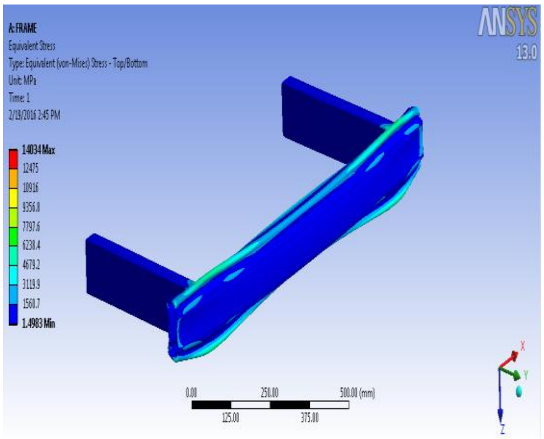


Figure 10 Von mises stress for GFRP from ANSYS

3. Results and Discussion

1.CHARPY-IMPACT TEST:

Test specifications

- Hammer weight - 21kg
- Hammer material - High Carbon Steel
- 1 division of scale- 2 joules
- Hammer held at 140°

Figure 11 Charpy Impact Test

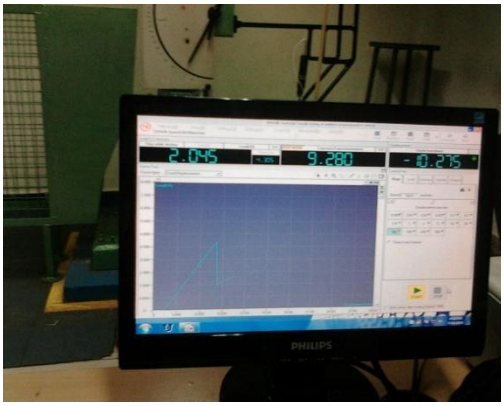


Figure 12 Charpy Impact Test

The Charpy Test is conducted to determine the absorbed energy on impact. As the material used was a composite material, notch is not provided. Alternative method to this procedure can be conducted by IZOD Impact Test.

2 TENSILE TEST:

Test specifications

- Maximum Capacity – 400KN
- Ram Stroke – 200mm
- Clearance – 500mm
- Least Count – 0.01mm
- Load Mean Device – Load cell

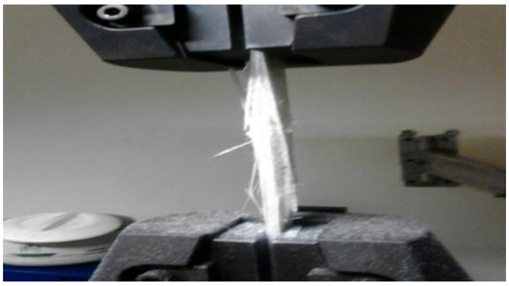


Figure 13 Tensile Test Equipment

Figure 14 Tensile Test Equipment

The Tensile Test is performed to determine the maximum withstandable load and to determine the Ultimate Tensile Strength.

3 FLEXURAL TEST:

Test specifications

- Gauge Width -24.59mm
- Gauge Thickness - 4.91mm
- Load Diameter - 6mm
- Type of Loading- Uniform Gradual Loading

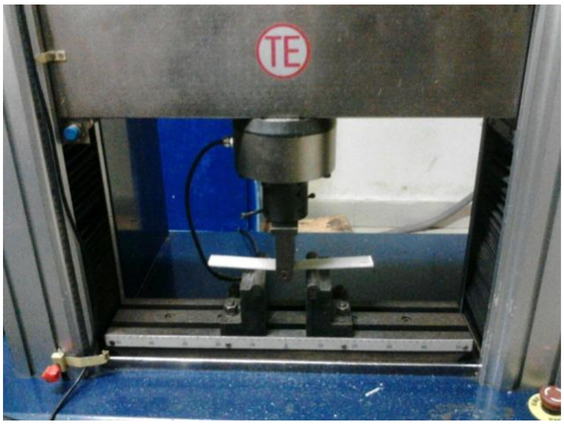
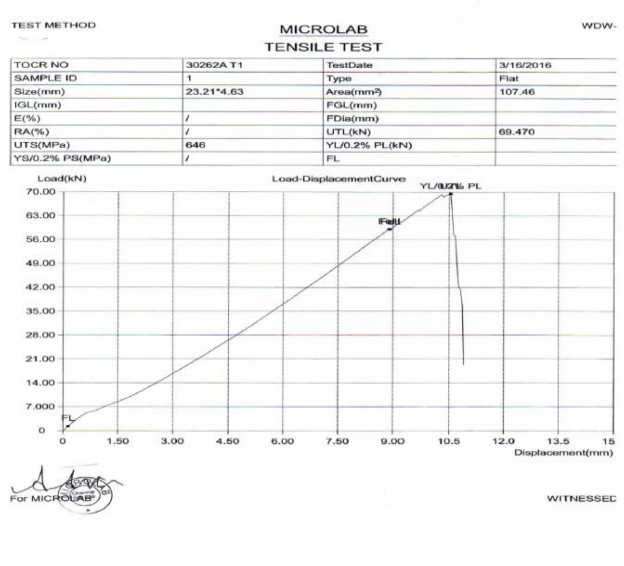


Figure 15 Flexural Test Equipment

The Flexural Test conducted has a span length of 75mm and uniform gradual loading is maintained throughout.

GRAPHS FOR TENSILE TEST:

LOAD-DISPLACEMENT CURVE OF TENSILE TEST(SAMPLE-1):



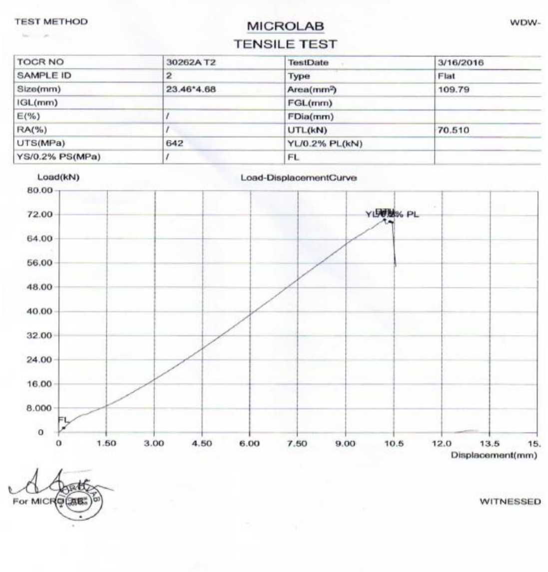
TEST METHOD WDW-

MICROLAB
TENSILE TEST

TOCR NO	30262A T1	TestDate	3/16/2016
SAMPLE ID	1	Type	Flat
Size(mm)	23.21*4.63	Area(mm²)	107.46
IGL(mm)		FGL(mm)	
E(%)	/	FDia(mm)	
RA(%)	/	UTL(kN)	69.470
UTS(MPa)	646	YL/0.2% PL(kN)	
YS/0.2% PS(MPa)	/	FL	

Theabove graph indicates the Ultimate Tensile Strength of 646 MPa is obtained during the Tensile Test.

LOAD-DISPLACEMENT CURVE OF TENSILE TEST(SAMPLE-2):


TEST METHOD

WDW-

MICROLAB

TENSILE TEST

TOCR NO	30262A T2	TestDate	3/16/2016
SAMPLE ID	2	Type	Flat
Size(mm)	23.46*4.68	Area(mm²)	109.79
IGL(mm)		FGL(mm)	
E(%)	/	FDia(mm)	
RA(%)	/	UTL(kN)	70.510
UTS(MPa)	642	YL/0.2% PL(kN)	
YS/0.2% PS(MPa)	/	FL	

Theabove graph indicates the Ultimate Tensile Strength of 642 MPa is obtained during the Tensile Test.

4 CONCLUSION

According to the obtained numerical results, it was found that the well laminated GFRP reinforced with epoxy fabricated bumper is having more strength and also less weight when compared to that of existing materials like steel and plastic.Based on the results obtained from the Ansys software, GFRP had better deformation compared to steel and CFRP. To validate this, laminate of GFRP with Epoxy resin has been fabricated and was subjected to the various tests to prove the properties. From the observed result it was found that displacement was higher for the GFRP. This results in increasing failure duration which causes the Strain rate to enhance.Hence, the GFRP reinforced with epoxy is better compared to steel in terms of the bumper beam application. Hence the steel which is currently being used in the industry can be replaced by GFRP.Finally it is concluded that glass reinforced with epoxy composite material based bumper material is suitable for automotive application of car bumper.

5.REFERENCES

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