Modeling and Static Analysis of Car Bumper

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Abstract - Bumper plays an imperative part in keeping the effective energy from being transferred to a vehicle and travelers. Sparing the effect energy in the bumper to be discharged in the environment decreases the harms of the vehicles. The main objective of this paper is to outline a bumper with least weight by utilizing the Glass Material Thermoplastic (GMT) materials. This bumper either ingests the effect energy with its distortion or exchanges it opposite to the effect direction. To achieve this point, an instrument is intended to change over around 80% of the kinetic effect energy to the spring potential energy and discharge it in an environment in the low effect speed as indicated as American standard. Likewise, since the residual kinetic energy will be damped with the minute versatile disfigurement of the bumper components, the passengers won't detect any effect. It ought to be noticed that in this paper, modeling, and result analysis are shown in Pro-E and ANSYS programming respectively.

Keywords - Car bumper, Pro-E and ANSYS programming

1.1 INTRODUCTION

Present days, Substitution of polymeric based composite material in car parts was effectively actualized in the journey for fuel and weight reductionq. Among the parts in the car business substituted by polymeric based composite materials are the bumper bar, bumper sash, spoiler, associating bar, pedal box framework, and entryway inward board. The bumper framework comprises of three fundamental parts, to be specific bumper pillar, belt and energy safe bumper. One of the choices to decrease energy utilization is weight diminishment.

Nonetheless, the architect ought to know that to diminish the weight; the wellbeing of the auto traveler must not be yielded. Another creation in innovation material was presented with polymeric based composite materials, which offer high particular solidness, low weight, erosion free, and capacity to deliver complex shapes, high particular quality, and high effect energy ingestion.

The car body is one of the basic subsystems of a vehicle, and it does different capacities. It should hold the parts of the vehicle together and serve to channel commotion and vibration. Moreover, it ought to have the capacity to ensure its tenants when mishaps happen. To do this, the car body originator ought to make a structure with critical levels of quality, solidness, and energy retention.

Fig 1: Car Bumper

1.2 DESIGN OF BUMPER FOR VEHICLE SAFETY

As the limitations, the fatality rate increments drastically in fast effects. Keeping in mind that, an effective lightweight vehicle and essentially enhance the crash execution of current vehicles, innovative advancement is at yet required. On the off chance that the car body could expand its front end amid or just before a crash, the system of retaining the crash energy would be very surprising from that of the passive structure.

During a frontal crash, the front side part is required to overlap dynamically, in order to retain more energy and to guarantee enough traveler space. To do as such, different cross segments and shapes have been explored for the front rail of the car body to boost crashworthiness and weight productivity; their outline included strengthening the cross-segment.

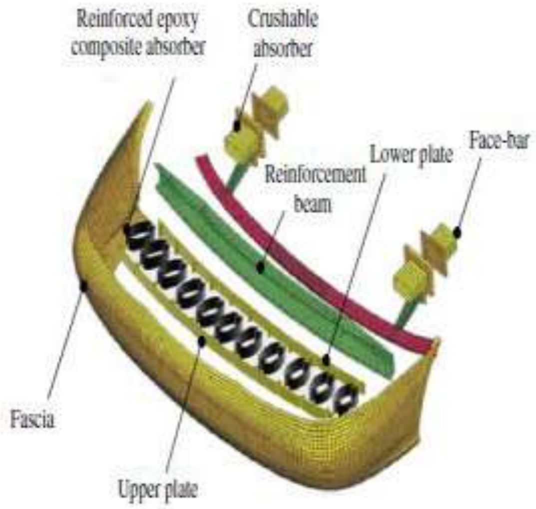


Fig 2: Automotive bumper system component

Today, what is fascinating related of this examination is currently an imaginative inflatable bumper idea, called the "I-bumper," is created in this exploration for enhanced crashworthiness and wellbeing of military and business vehicles. The created I-bumper has a few dynamic basic parts, including a transforming component, a versatile bumper, two unstable airbags, and a transforming grid structure with a locking instrument that gives wanted inflexibility and energy ingestion ability amid a crash. Another imaginative enhancing crashworthiness is the use of tubes loaded with a granular material to assimilate energy amid of a crash.

1.3 MATERIAL PROPERTIES

1. High Strength to weight ratio
2. Rigidity
3. Corrosion resistance
4. Electrical Conductivity
5. Fatigue Resistance
6. Good tensile strength but Brittle
7. Fire Resistance/Not flammable
8. High Thermal Conductivity in some forms
9. Low coefficient of thermal expansion
10. Biologically inert
11. Self Lubricating
12. Excellent EMI (Electromagnetic Interference) Shielding Property
13. Relatively Expensive

1.4 OBJECTIVES AND SCOPES

a) To break down the mechanical properties on front part (belt) of auto bumper:
I. To examine on mechanical properties concentrate on stretch examination
ii. To displaying the genuine measurement of the vehicle bumper into the UG software and examine by utilizing FEA programming (Analysis).
iii. To research polymer composite material bumper (Proton Pesona) in view of their geometry and different parameters that impact the similarity of vehicle bumper.
b) To assess failures component of the car bumper:
I. To think about the load dispersion on the bumper possibly it is consistently conveys to all the part amid the analysis.
ii. To anticipate the basic point.
their UI(user interface) toward interactive windows frameworks.

2 MODELING

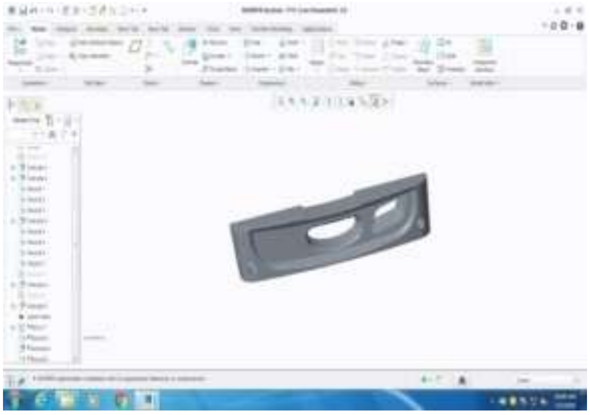


Fig 3: modelling of bumper

3 STRUCTURAL ANALYSIS

Steps followed in ansys workbench

3.1 Importing the Model

In this step the PRO-E model is imported into ANSYS workbench as follows:

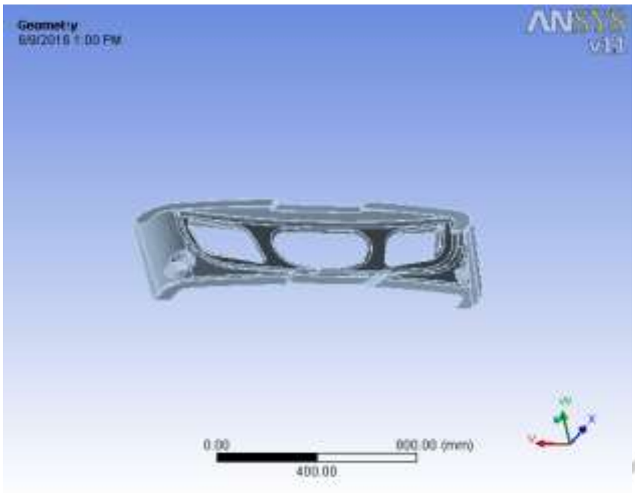


Fig 4: Imported Geometry

In utility menu record alternative and select import outside geometry and open document and tap on produce. To go into recreation module tap on venture tab and tap on new reenactment.

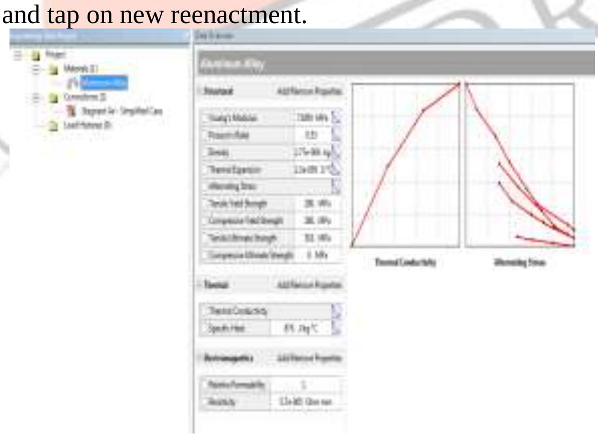


Fig 5: Defining material properties

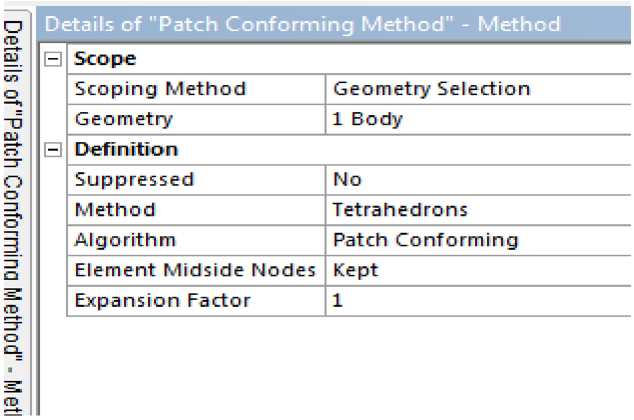
3. 2 Defining Element Type

To characterize kind of component for the examination, Picked the fundamental menu, select sort of contacts and after that tap on work right snap embed strategy

Technique - Tetrahedrons

Calculation - Patch Conforming

Component Midside Nodes – Kept



Details of "Patch Conforming Method" - Method

Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Suppressed	No
Method	Tetrahedrons
Algorithm	Patch Conforming
Element Midside Nodes	Kept
Expansion Factor	1

Fig 6: Defining element type

3.3 Meshing the model

To play out the cross section of the model these means are to be taken after:

Picked the principle menu tap on work right snap embed measuring and afterward select geometry enter component size and after that tap on create work.

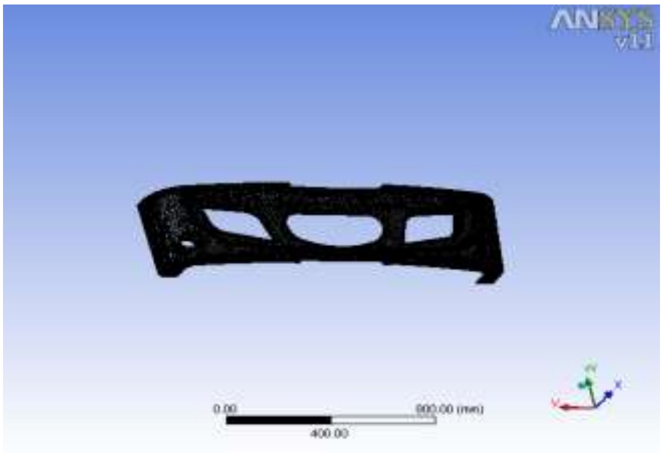


Fig 7: Meshing model

3.4 Applying Boundary conditions and Loads

To apply the limiting conditions on the model these means are to be taken after:

Picked the primary menu, tap on new investigation tab select static, tap on face and after that select face of the geometry-right snap embed settled. Pick the principle menu, select face and tap on face of geometry-right snap – embed – drive

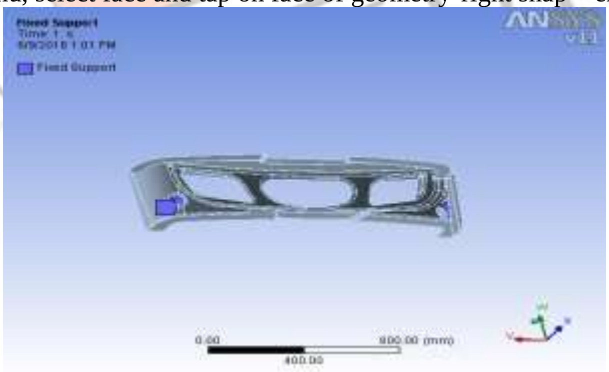


Fig 8: Fixed supports

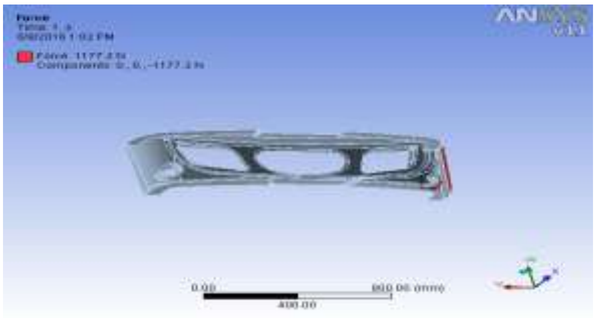


Fig 9: Force application

Aluminum A390 alloy Properties
Static Structural Analysis

Properties	
Density (×1000 kg/m^3)	2.6-2.8
Poisson's Ratio	0.33
Elastic Modulus (GPa)	70-80
Tensile Strength (Mpa)	180
Yield Strength (Mpa)	180
Elongation (%)	<1.0

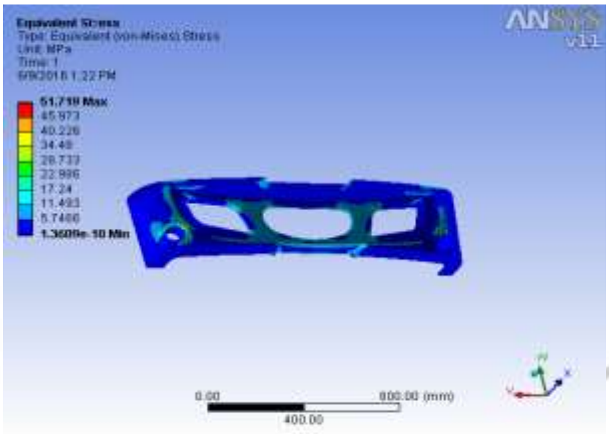


Fig 10: Equivalent stress

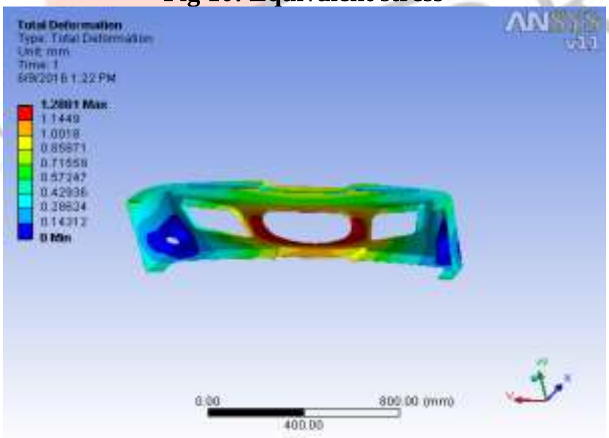


Fig 11: Total Deformation

Deformations at different freqency for Aluminum A390 are as follows

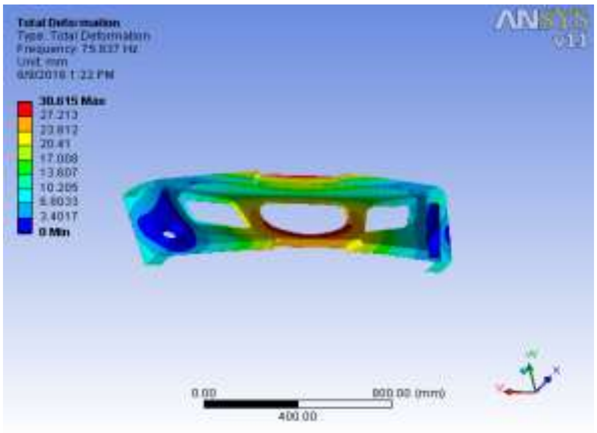


Fig 12: Mode 1 ,deformation at 75.837Hz Frequency

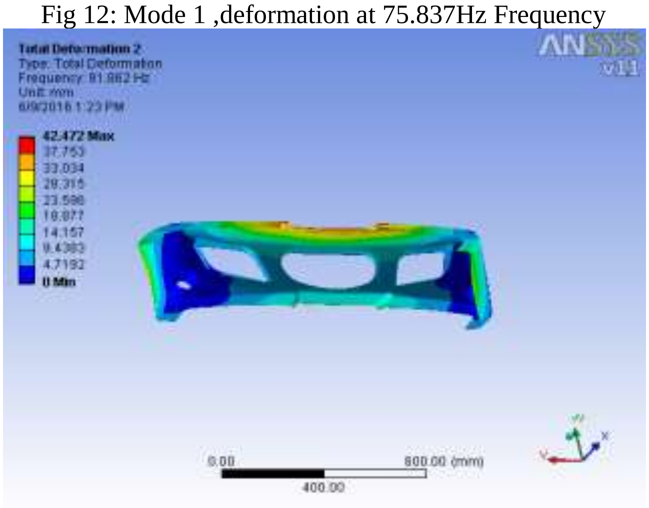


Fig 13: Mode 2, deformation at 91.862Hz Frequency

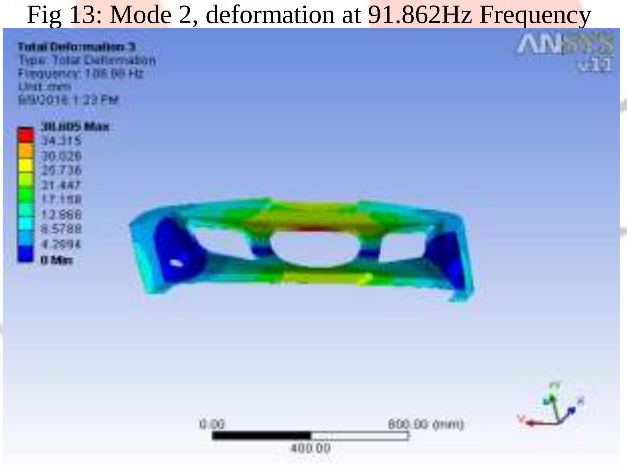


Fig 14: Mode 3, deformation at 108.98Hz Frequency

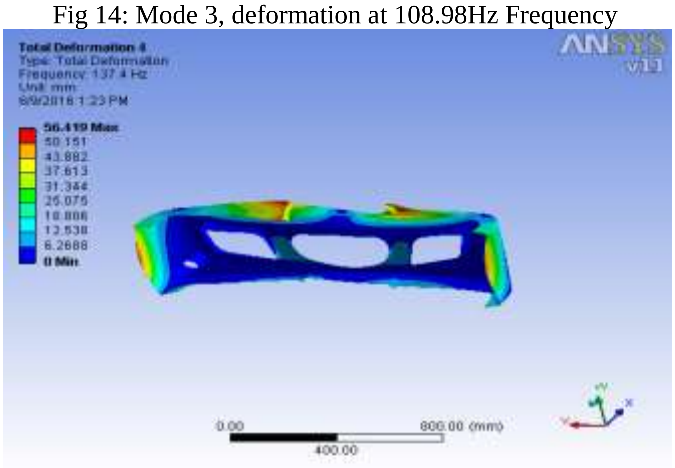


Fig 15: Mode 4, deformation at 137.4Hz Frequency

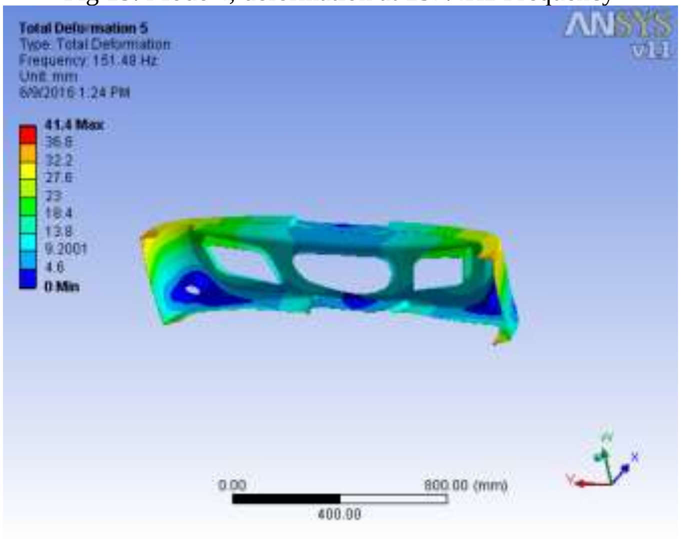


Fig 16 : Mode 5, deformation at 151.48Hz Frequency

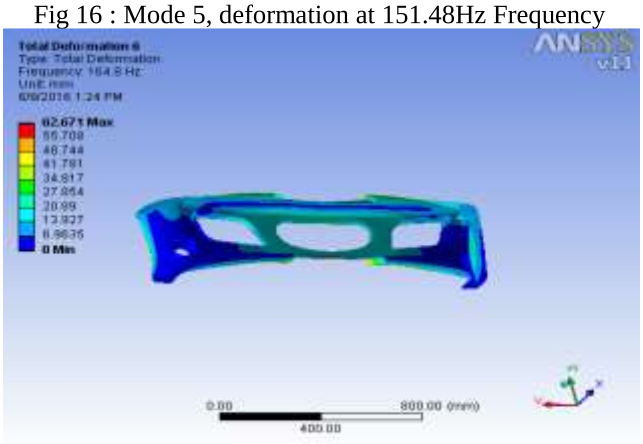


Fig17: Mode 6, deformation at 164.8Hz Frequency

Carbon Fiber Properties
Static structural analysis

Young's modulus	3.88e+005 Mpa
Poisson's ratio	0.358
Density	1.6e-006 kg/m3
Thermal expansion	$0.11/^{0}c$

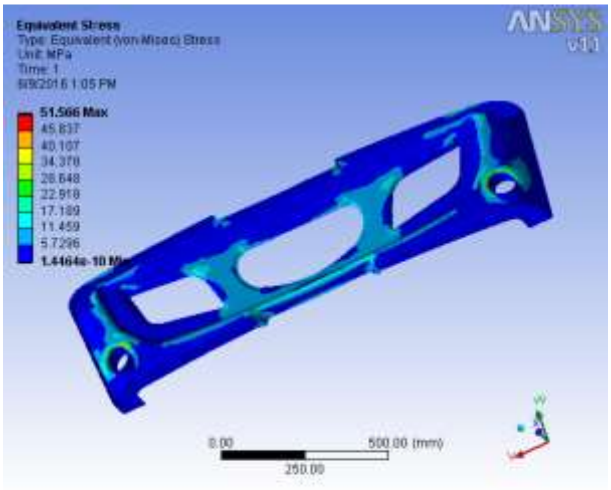


Fig 18: Equivalent stress

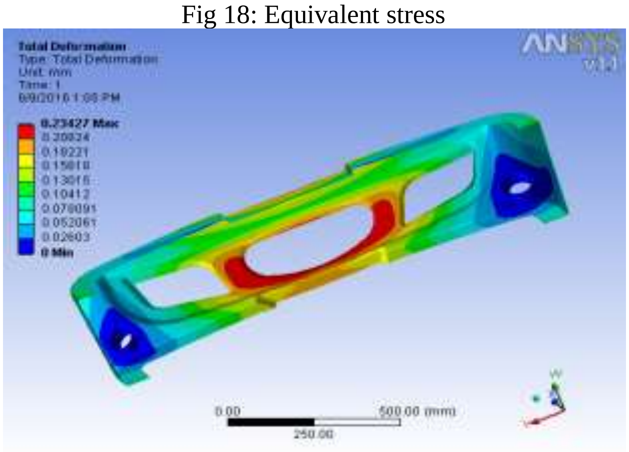


Fig 19: Total Deformation

Deformations at different freqency for Carbon Fiber are as follows

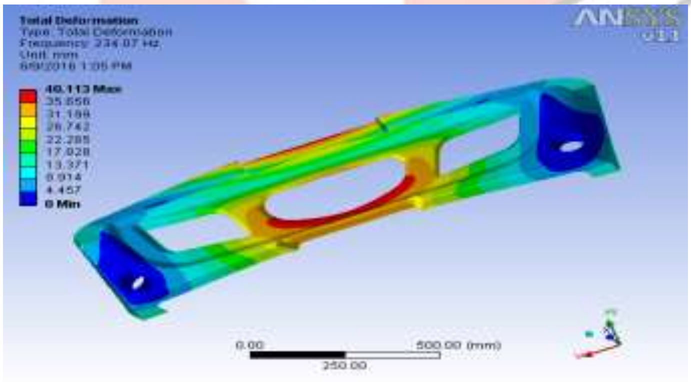


Fig 20 : Mode 1, deformation at 234.07Hz Frequency

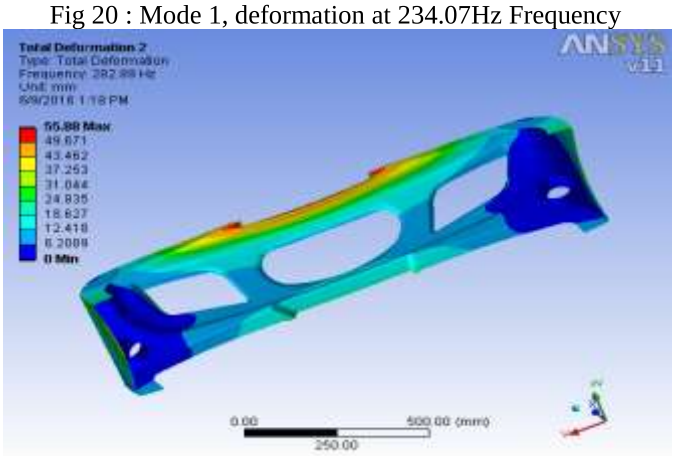


Fig21: Mode 2 deformation at 282.89Hz Frequency

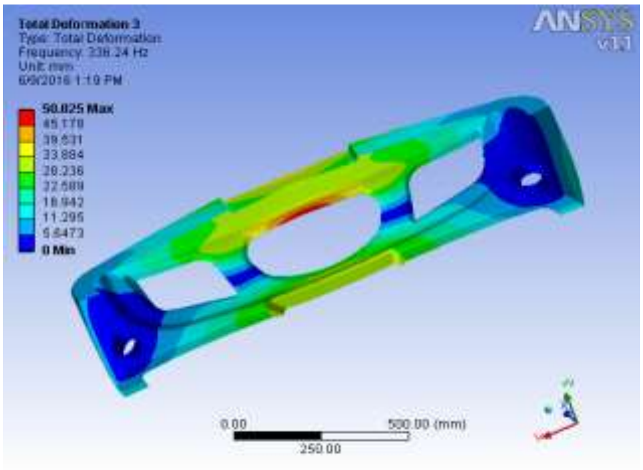


Fig 22: Mode 3, deformation at 336.24Hz Frequency

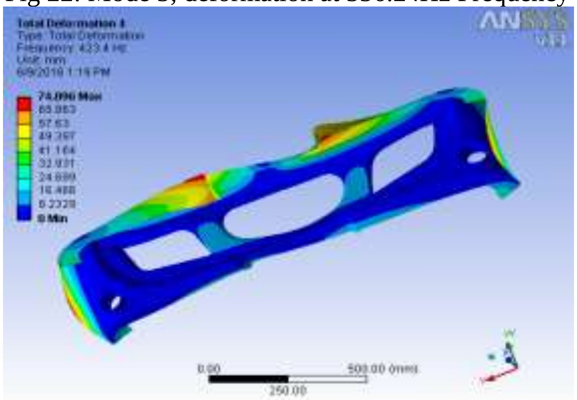


Fig 23 : Mode 4, deformation at 423.4Hz Frequency

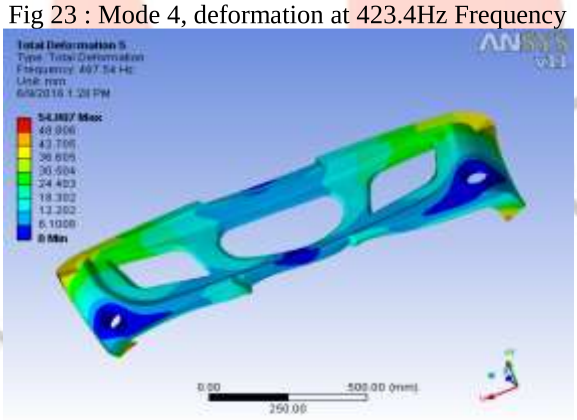


Fig 24 : Mode 5, deformation at 467.54Hz Frequency

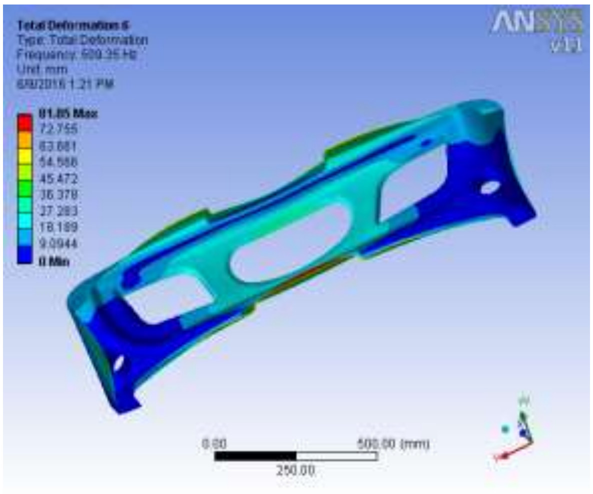


Fig 25: Mode 6, deformation at 509.35Hz Frequency

mild steel properties

mild steel contains:
carbon 0.16 to 0.18 % (maximum0.25% is allowable)
Manganese : 0.70 to 0.90 %
Silicon maximum: 0.40%
Sulfur maximum : 0.04%
Phosphorous maximum : 0.04%
Mildest grade of carbon steel or mild steel contains a very low amount of carbon - : 0.05 to 0.26%

modulus of elasticity	210,000 Mpa
density	7860 kg/m3
Thermal expansion	2.3e-0051/^{0}c
Poisson's ratio	0.303

Static structural analysis

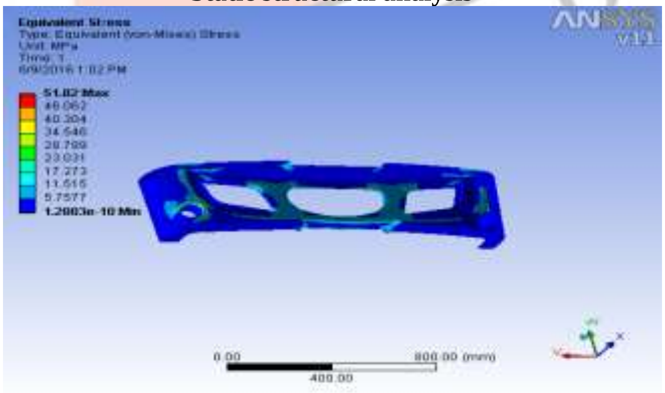


Fig 26: Equivalent stress

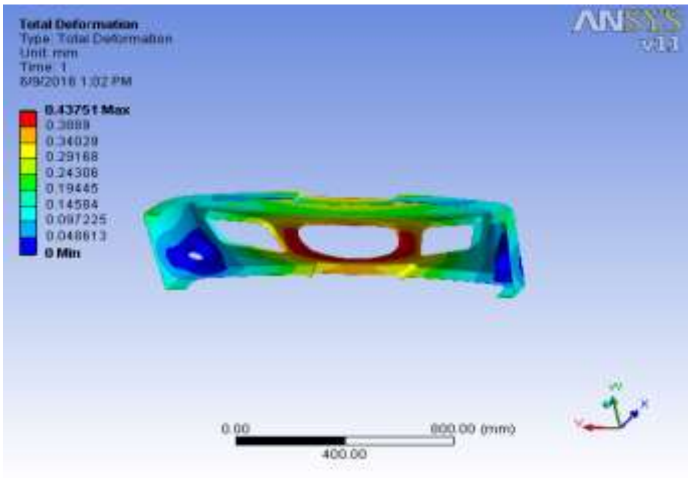


Fig 27: Total Deformation

Deformations at different freqency for mild steel are as follows

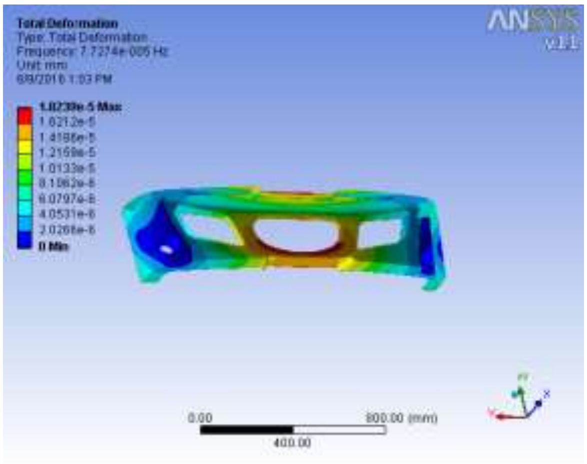


Fig 28: Mode 1, deformation at 7.727e-005Hz Frequency

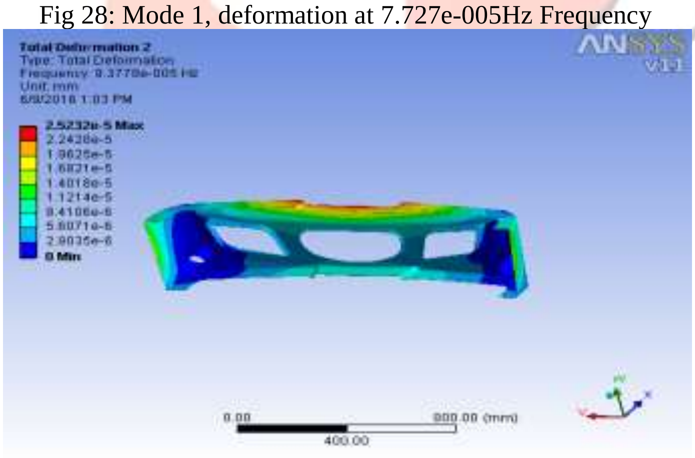


Fig 29: Mode 2, deformation at 9.3778e-005Hz Frequency

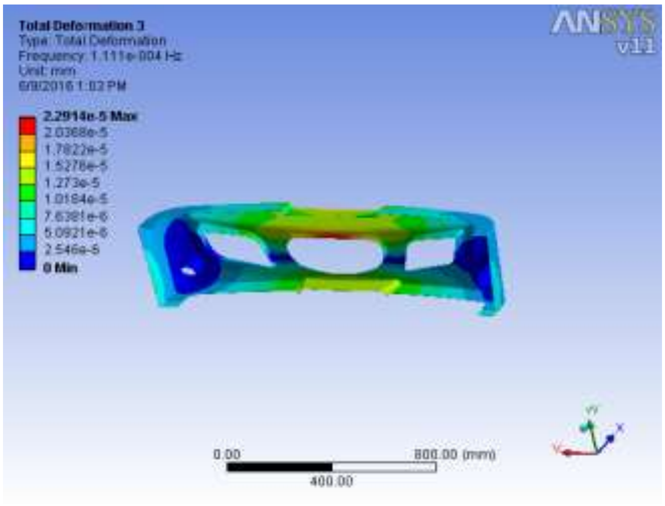


Fig 30: Mode 3, deformation at 1.111e-004Hz Frequency

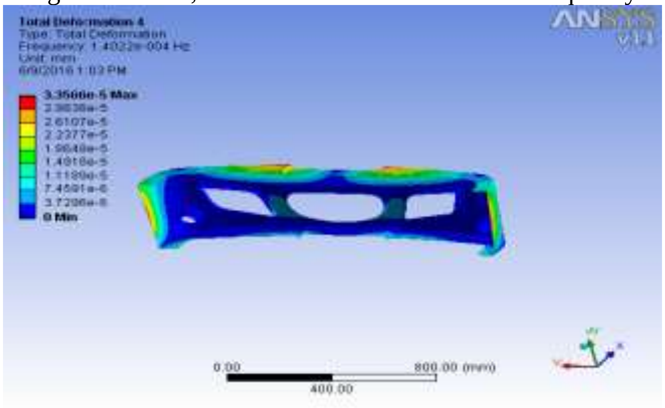


Fig31: Mode 4, deformation at 1.4022e-004Hz Frequency

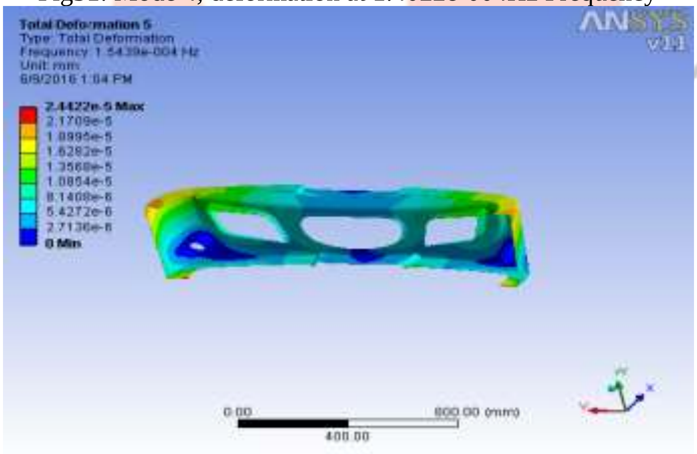


Fig32: Mode 5, deformation at 1.5439e-004Hz Frequency

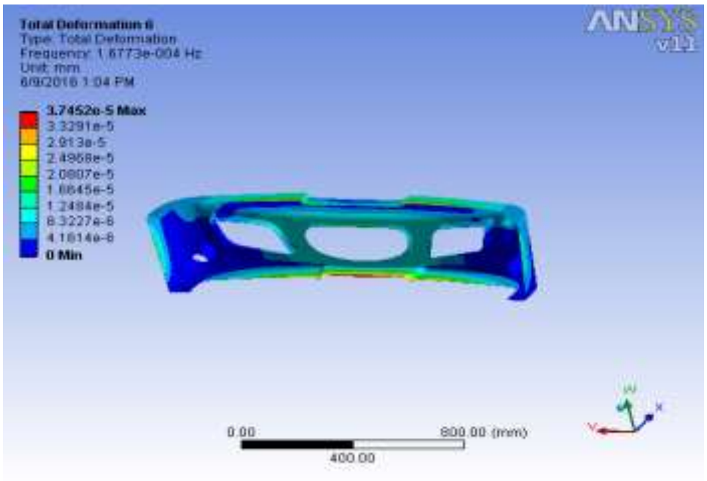


Fig33: Mode 6, deformation at 1.6773e-004Hz Frequency

DYNAMIC ANALYSIS

Material: Carbon Fiber

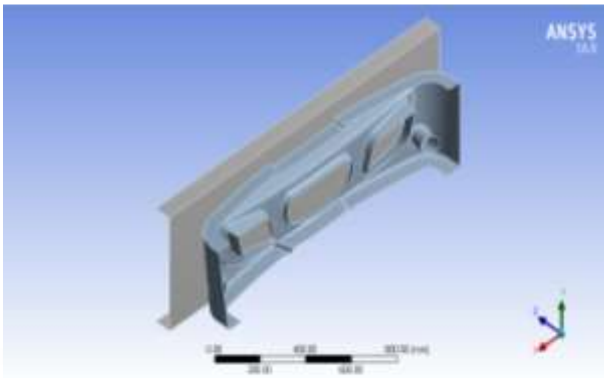


Fig34: Geometry

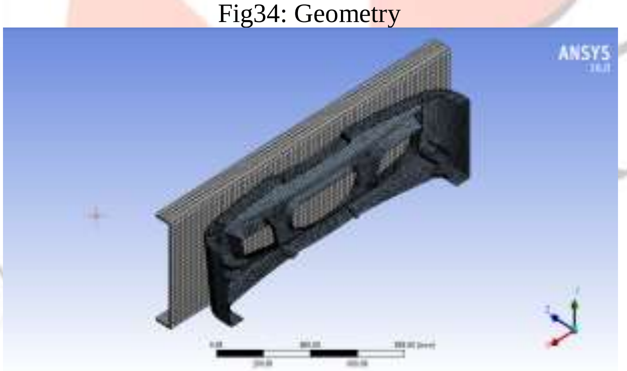


Fig35: Messing part

Statistics	
Nodes	13971
Elements	73498

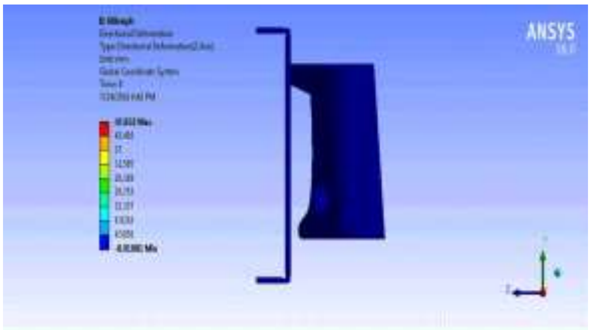


Fig36: Directional Deformation-z Hitting Wall With 60 Km/Hr

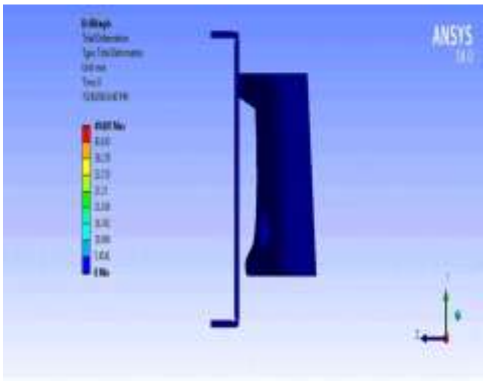


Fig 38: Total Deformation With 60 Km/Hr

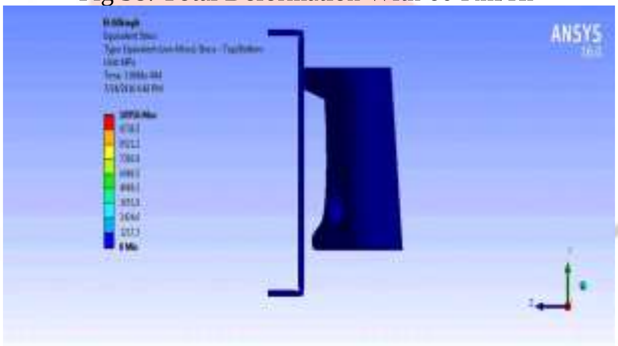


Fig 39: Equivalent stress With 60 Km/Hr

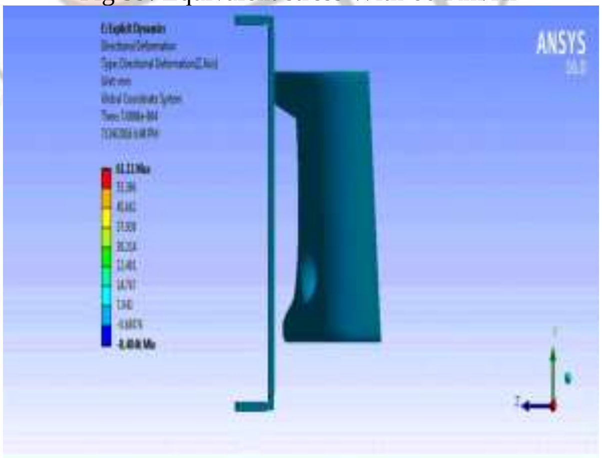


Fig40 : Directional Deformation-z Hitting Wall With80 Km/Hr

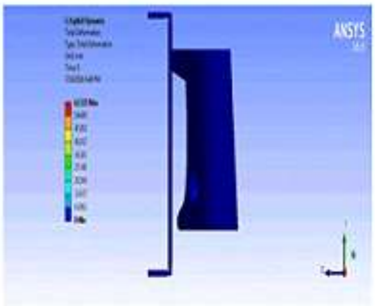


Fig 41: Total Deformation With80 Km/Hr

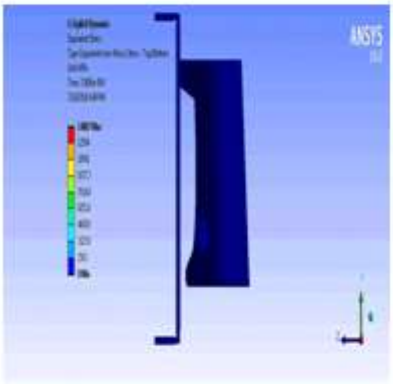


Fig 42: Equivalent stress With80 Km/Hr

RESULTS AND DISCUSSION

Mode	Aluminum A390 alloy		Carbon Fiber		Mild steel	
	Frequency (Hz)	Total deformation (mm)	Frequency (Hz)	Total deformation (mm)	Frequency (Hz)	Total deformation (mm)
Mode 1	75.837	30.615	234.07	40.113	7.727e-005	1.8239
Mode 2	91.862	42.472	282.89	55.88	9.377e-005	2.2532
Mode 3	108.98	38.605	336.24	50.825	1.111e-004	2.2914
Mode 4	137.4	56.419	423.4	74.096	1.440e-004	3.3566
Mode 5	151.48	41.4	467.54	54.907	1.543e-004	2.4422
Mode 6	164.8	62.671	509.35	81.85	1.677e-004	3.7452

Equivalent stress and Total Deformation

Materials	Equivalent stress(Mpa)	Total Deformation(mm)
Aluminum A390 alloy	51.719	1.2881
Carbon Fiber	51.566	0.23427
Mild steel	51.82	0.43751

Dynamic analysis results:

Material	Directional deformation - Z(mm)	Total deformation(mm)	Equivalent stress(Mpa)	Material	Directional deformation - Z(mm)	Total deformation(mm)
	60kmph	80kmph	60kmph	80kmph	60kmph	80kmph
Carbon Fiber	47.832	61.11	49.087	61.525	10.956	14.067

CONCLUSION

As we seen the above results, the total deformation and equivalent stresses are minimum in carbon fiber material. So, the material used for bumper as we preferred is carbon fiber.

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