© 2020 | International Journal of Scientific Research in Science and Technology
IJSRST | Volume 7 | Issue 1 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
DOI : https://doi.org/10.32628/IJSRST

Design and Analysis of An Automotive Bumper

R Sreekantha Reddy[1], C Raghunath Reddy[2]

[1]M. Tech Scholar, Department of Mechanical Engineering College, Tadipatri Engineering College, Tadipatri, Andhra Pradesh, India

[2]Assistant Professor, Department of Mechanical Engineering College, Tadipatri Engineering College, Tadipatri, Andhra Pradesh, India

ABSTRACT

Bumpers play an important role in preventing the impact energy from being transferred to the automobile and passengers. Saving the impact energy in the bumper to be released in the environment reduces the damages of the automobile and passengers. The goal of this paper is to design a bumper with minimum weight by employing the Glass Material Thermoplastic (GMT) materials. This bumper either absorbs the impact energy with its deformation or transfers it perpendicular to the impact direction. To reach this aim, a mechanism is designed to convert about 80% of the kinetic impact energy to the spring potential energy and release it to the environment in the low impact velocity according to American standard. In addition, since the residual kinetic energy will be damped with the infinitesimal elastic deformation of the bumper elements, the passengers will not sense any impact. It should be noted that in this paper, modeling, and result's analysis are done in Pro-E and ANSYS software respectively.

Keywords :, Glass Material Thermoplastic, Pro-E , ANSYS, Expanded Polypropylene

I. INTRODUCTION

BACKGROUND OF THE STUDY

Nowadays, in development of technology especially in engineering field make among the engineers more creative and competitive in designing or creating new product. They must be precise and showing careful attentions on what they produce. Here, we concentrate on automotive industry. The greatest demand facing the automotive industry has been to provide safer vehicles with high fuel efficiency at minimum cost. Current automotive vehicle structures have one fundamental handicap, a short crumple zone for crash energy absorption.

One of the options to reduce energy consumption is weight reduction. However, the designer should be aware that in order to reduce the weight, the safety of the car passenger must not be sacrificed. A new invention in technology material was introduced with polymeric based composite materials, which offer high specific stiffness, low weight, corrosion free, and ability to produce complex shapes, high specific strength, and high impact energy absorption.

Substitution of polymeric based composite material in car components was successfully implemented in the quest for fuel and weight reduction. Among the components in the automotive industry substituted by polymeric based composite materials are the bumper beam, bumper fascia, spoiler, connecting rod, pedal box system, and door inner panel. The bumper system consists of three main components, namely bumper beam, fascia and energy absorber.

The automotive body is one of the critical subsystems of an automobile, and it carries out multiple functions. It should hold the parts of the vehicle together and serve to filter noise and vibrationTo do this, the automotive body designer should create a structure with significant levels of strength, stiffness, and energy absorption.

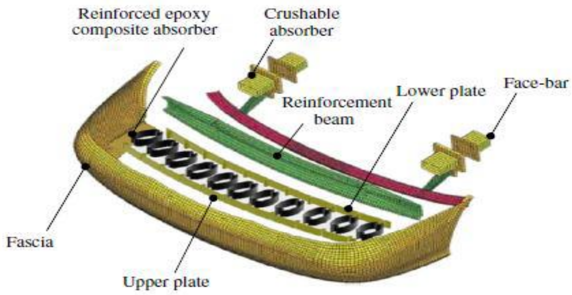
Bumper

BUMPER DESIGN FOR VEHICLE SAFETY

Because of these limitations, the fatality rate increases dramatically in high speed impacts. In order to design a successful lightweight vehicle and significantly improve the crash performance of current cars, technological development is still needed. If the automotive body could extend its front end during or right before a crash, the mechanism of absorbing the crash energy would be totally different from that of the passive structure.

During a frontal crash, the front side member is expected to fold progressively, so as to absorb more energy and to ensure enough passenger space. To do so, various cross sections and shapes have been investigated for the front rail of the automotive body to maximize crashworthiness and weight efficiency; their design included reinforcing the cross-section.

For several decades, bumper design has focused on material and structure. Andersson et al. (2002) investigated the applicability of stainless steel for crash-absorbing bumpers to increase crash performance in automotive vehicles. Butler (2002) studied the design of efficient epoxy structural foam reinforcements to increase the 9 energy absorbed in front and rear automotive bumper beams. Carley (2004) introduced Expanded Polypropylene (EPP) foam technologies and techniques for bumper systems. Cheon et al. (1995) developed a new composite bumper that has two pads at each end of the bumper. Evans and Morgan (1999) studied thermoplastic energy absorbers for bumpers.



Automotive bumper system component

Today, what is interesting related of this research is now an innovative inflatable bumper concept, called the "I-bumper," is developed in this research for improved crashworthiness and safety of military and commercial vehicles. The developed I-bumper has several active structural components, including a morphing mechanism, a movable bumper, two explosive airbags, and a morphing lattice structure with a locking mechanism that provides desired rigidity and energy absorption capability during a collision. Another additional innovative means for improving crashworthiness is the use of tubes filled with a granular material to absorb energy during the process of a crash.

II. METHODS AND MATERIAL

MATERIAL PROPERTIES

The common use of the term stress analysis includes any kind of structural analysis. In the field of thermoplastics design, there is a growing awareness of the importance of stress analysis. In many years, plastics have been used for applications in load-bearing structural components in the automotive, aerospace, sporting, and construction industries. Hence, design engineers are increasingly concerned about stress-related problems, typically with the strength, stiffness and life expectancy of their products. About many years ago, these problems were primarily associated with the metallic components. Stress analysis has always been interdisciplinary, because an effective analysis needs to bring together a thorough knowledge of the operating characteristic of the product, material behavior, structural behavior and solid mechanics. Structural plastics design is a field that is evolving in the same manner as did the aero-space and nuclear power industries. That is, a sequence of products innovations, and better methods of design and analysis continuously reinforce each other and lead to the optimum design of the product. Stress analysis is a vital activity in this process.

From the point of view of stress analysis, are the thermoplastics very different from metals? The answer is yes and no. Yes, because a few types of behaviors of thermoplastic materials call for advanced techniques of analysis, because such behaviors are encountered only in special applications of metals.

No, because several calculations and test procedures for characterizing the mechanical properties of thermoplastics are very similar to those of metals. Thus such stress analysis is also similar. Material properties of plastics such as elastic modulus, yield point, tensile strength and fracture toughness are understood, measured and used in a manner similar to those for metals. Many structural plastics design may be performed using the familiar strength of material approach. Likewise detailed stress analyses of plastic components are performed assuming linear elastic behavior.

PROBLEM STATEMENT

From the previous research or analysis on car bumper, basically they focus on the design and crashworthiness optimization. However, for this analysis just focusing on the stress analysis on car bumper by applying various loads on the static condition only. In the real situation, there is much point that bumper mounting to the car which make it stronger or can absorb more energy during the impact. For the simulation, just take fixed point both end of the bumper. Only the fascia part of the bumper will take into account.

TYPES OF CAR BUMPERS

Plastic Bumper

Most modern cars use a reinforced thermoplastic bumper, as they are cheap to manufacture, easy to fit and absorb more energy during a crash. A majority of car bumpers are custom made for a specific model, so if you are looking to replace a cracked bumper with a similar one, you would have to buy from a specialist dealer. However, many companies now offer alternative designs in thermoplastic, with a range of fittings designed for different models.

Body Kit Bumper

Modified cars often now have a full body kit rather than just a front and rear bumper. These kits act as a skirt around the entire body of the car and improve performance by reducing the amount of air flowing underneath the car and so reducing drag. Due to each car's specifications, these have to be specially purchased and can be made from thermoplastic, like a standard bumper, or even out of carbon fiber.

Carbon Fiber Bumper

Carbon fiber body work is normally the thing of super-cars, but many car companies, and specialist modifiers, are starting to use it for replacement body part on everyday cars. This is because it is very light and is safe during a crash. It is, however, a lot more expensive than normal thermoplastic.

Steel Bumper

Originally plated steel was used for the entire body of a car, including the bumper. This material worked well, as it was very strong in a crash, but it was very heavy and dented performance. As car engine design has improved, steel bumpers have pretty much disappeared for anything except classic cars. Replacing one involves a lot of searching for scrap cars or having one specially made. Improving passenger car damageability and reparability has been an important RCAR topic since the Council was established in 1972. In order to prevent unnecessary damage to the structure of passenger cars in low speed crashes, a 15 km/h, 40 % overlap test was implemented in the 1980s and revised again in 2006 (the impact angle was changed from 0° to 10° and the rear impact moving barrier weight was increased from 1000 to 1400kg). This test is referred to as the RCAR Structural Test. Car manufacturers design their vehicles to perform well in this RCAR structural test but some have fitted vehicles with countermeasures that do not exhibit good crash behavior in real world crashes. In some cases, manufacturers have eliminated the bumper beam and replaced them with localized countermeasures, such as crush cans, to manage the test. Such sub-optimized designs are in most cases not robust and often lead to expensive damage in car-to-car crashes. Insurance claims data indicate that rear bumpers are often under-ridden by a striking vehicle due to bumper system instability or vertical dive of vehicles during braking. In these cases it is desirable to have bumper systems that have sufficient vertical overlap to maintain engagement. To this end, bumpers should ideally be mounted at slightly different heights front and rear but have sufficient height to maintain engagement over a wide range of circumstances. However, insurance data also show that rear bumpers are overridden when struck by high ride-height vehicles (SUVs, pickup trucks). Vehicle damageability would be improved in both these situations with taller front and rear bumper beams. Real world claims data also show a significant number or crashes in which damage is limited to the vehicle corners. Vehicle bumpers should prevent or limit much of the damage sustained in these minor crashes. However, many vehicles do not have bumper reinforcement beams that extend laterally much beyond the frame rails, leaving expensive vehicle components such as headlamps and fenders (wings) unprotected. An international RCAR working group has developed test procedures to assess how well a vehicle's bumper system protects the vehicle from damage in low speed impacts. Damage in these tests closely replicates the damage patterns observed in real world low speed crashes and addresses three components of bumper

Performance

1. Geometry – vehicle bumpers need to be positioned at common heights from the ground and extend laterally to the corners in order to properly engage other vehicles in low speed crashes.
2. Stability – vehicle bumpers need to be tall and wide enough to remain engaged with the bumpers of other vehicles despite vehicle motion due to loading, braking, etc.

III. COMPOSITE MATERIALS

OVERVIEW OF COMPOSITE MATERIALS

Composites are made up of individual materials referred to as constituent materials. There are two main categories of constituent materials: matrix and reinforcement. At least one portion of each type is required. The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions. The reinforcements impart their special mechanical and physical properties to enhance the matrix properties. A synergism produces material properties unavailable from the individual constituent materials, while the wide variety of matrix and strengthening materials allows the designer of the product or structure to choose an optimum combination.

A variety of moulding methods can be used according to the end-item design requirements. The principal factors impacting the methodology are the natures of the chosen matrix and reinforcement materials.

Advantages of Composites

Light Weight - Composites are light in weight, compared to most woods and metals. Their lightness is important in automobiles and aircraft, for example, where less weight means better fuel efficiency (more miles to the gallon). People who design airplanes are greatly concerned with weight, since reducing a craft's weight reduces the amount of fuel it needs and increases the speeds it can reach. Some modern airplanes are built with more composites than metal including the new Boeing 787, Dreamliner.

High Strength - Composites can be designed to be far stronger than aluminium or steel. Metals are equally strong in all directions. But composites can be engineered and designed to be strong in a specific direction.

Corrosion Resistance - Composites resist damage from the weather and from harsh chemicals that can eat away at other materials. Composites are good choices where chemicals are handled or stored. Outdoors, they stand up to severe weather and wide changes in temperature.

High-Impact Strength - Composites can be made to absorb the sudden force of a bullet, for instance, or the blast from an explosion. Because of this property, composites are used in bulletproof vests and panels, and to shield airplanes, buildings, and military vehicles from explosions.

Dimensional Stability - Composites retain their shape and size when they are hot or cool, wet or dry. Wood, on the other hand, swells and shrinks as the humidity changes. Composites can be a better choice in situations demanding tight fits that do not vary. They are used in aircraft wings, for example, so that the wing shape and size do not change as the plane gains or loses altitude.

Nonconductive - Composites are nonconductive, meaning they do not conduct electricity. This property makes them suitable for such items as electrical utility poles and the circuit boards in electronics. If electrical conductivity is needed, it is possible to make some composites conductive.

CONSTITUENTS OF COMPOSITE MATERIALS

The constituents or materials that make up the composites are resins and reinforcements.

Resins

The resin is an important constituent in composites. The two classes of resins are the thermoplastic and thermosets. The most common resins used in composites are the unsaturated polyesters, epoxy, and vinyl esters. The least common ones are the polyurethanes and phenolics.

1) Reinforcements

2) The reinforcements are solid part of the composites, which are reinforced in to the matrix. They determine the strength and stiffness of the composites. Most common reinforcements are fibres, particles and whiskers. Fibre reinforcements are found in both natural and synthetic forms. Fibre composite was the very first form of composites, using natural fibre such as straw was reinforced in clay to make bricks that were used for building.

FIBRE REINFORCED POLYMER

Fibre-reinforced plastic (FRP) (also fibre-reinforced polymer) is a composite material made of a polymer matrix reinforced with fibres. The primary function of fibre reinforcement is to carry load along the length of the fibre and to provide strength and stiffness in one direction. Fibre reinforced polymer composites are different from traditional construction materials like steel or aluminium.

FRP composites are anisotropic (properties apparent in the direction of applied load) whereas steel or aluminium is isotropic (uniform properties in all directions, independent of applied load) and FRP have maximum material stiffness to density ratio of 3.5 to 5 times that of aluminium or steel. The FRP have high fatigue endurance limits; can absorb impact energies, light weight and high strength. The main disadvantage of FRP materials is their relatively high cost compared to wood or unpainted low-carbon steel. Limited experience with FRP materials in the construction and design industry. FRP can be applied to strengthen the beams, columns, and slabs of buildings and bridges. FRPs are commonly used in the aerospace, automotive, marine, and construction industries.

Types of Fibre Reinforcements

The following are the kinds of fibre reinforcements:

Glass Fibres

Carbon Fibres

Natural Fibres

Boron Fibres

Fibres based on Silica

Fibres based on Alumina

Aramid fibres

High-Density Polyethylene Fibres

Advantages

Carbon fibre is extremely strong and these are widely used in manufacturing components that require durable strength and low weight.

Carbon fibre materials possess good rigidity, high strength, low density, corrosion resistance, vibration resistance, high ultimate strain, high fatigue resistance, and low thermal conductivity. They are bad conductors of electricity and are non-magnetic.

Disadvantages

Recycling of carbon fibre is very difficult and it cannot melt like steel to reuse. Also another difficulty once a carbon fibre structure is dinted or cracked it be cannot beat back into shape like steel or add a fibre glass layer like panel beaters do. Once that dint or crack has occurred the entire structure's modulus and tensile strength and other factors are flawed and the part would need to be thrown away and replaced.

Applications

Carbon Fibre in Aerospace engineering

Carbon fibre is also widely in aircraft components and structures, where its superior strength to weight ratio far exceeds that of any metal. 30% of all carbon fibre is used in the aerospace industry.

The Airbus A350 XWB is built of 53% CFRP including wing and fuselage components, the Boeing 787 Dreamliner is built of 50%. The A380 is the first commercial airliner to have a central wing box made of CFRP and it is also the first to have a smoothly contoured wing cross section instead of the wings beings partitioned span-wise into sections. This flowing, continuous cross section optimises aerodynamic efficiency. From helicopters to gliders, fighter jets to micro lights, carbon fibre is playing its part, increasing range and simplifying maintenance.

Sporting Goods

Its application in sports goods ranges from the stiffening of running shoes to ice hockey stick, tennis racquets, golf clubs, squash and shells (hulls for rowing). It is also used in crash helmets too, for rock climbers, horse riders and motor cyclists and in any sport where there is a danger of head injury.

Other applications

CFRP is also finding application in an increasing number of high-end products that require stiffness and low weight, these include:

Automobile Industry

- Laptop cases by an increasing number of manufacturers.
- Firearms use it to replace certain metal, wood, and fibreglass components but many of the internal parts are still limited to metal alloys as current reinforced plastics are unsuitable.
- High-performance radio-controlled vehicle and aircraft components such as helicopter rotor blades.
- Tripod legs, tent poles, fishing rods, billiards cues.
- Many other light and durable consumer items such as the handles of high-end knives.
- Poles for high reach, e.g. poles used by window cleaners and water fed poles.

MATERIAL PROPERTIES

Properties	Aluminum B396 Alloy	Carbon Fibre	Chromium coated mild steel
Young's Modulus(MPa)	7100	388	21000
Poisson's Ratio	0.33	0.358	0.303
Density (kg/mm^3)	277	1600	7850

IV. INRODUCTION TO SOFTWARES

COMPUTER AIDED DESIGN

Computer aided design is the use of wide range of computer based tools that assist engineers, architects and other design professionals in their design activities. Computer aided design encompasses a wide variety of computer based methodologies and tools for a spectrum of engineering activities planning, analysis, detailing, drafting, construction, manufacturing, monitoring, management, process control and maintenance. CAD is more concerned with the use of computer-based tools to support the entire life cycle of engineering system.

CAD is extensively used in the design of tools and machinery used in the manufacture of components. CAD is also used in the drafting and design of all types of buildings, from small residential types (houses) to the largest commercial and industrial types (hospitals and factories). CAD is used throughout the engineering process from conceptual design and layout, through detailed engineering and analysis of components to definition of manufacturing methods.

FIELDS OF USE

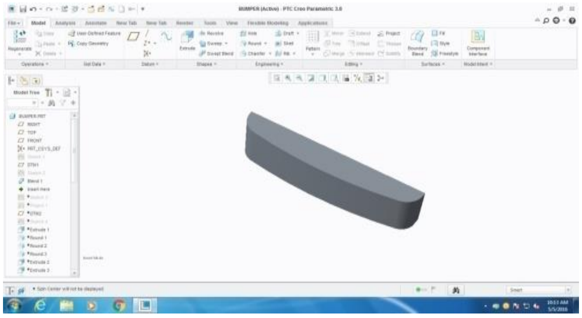
- ✓ Architecture
- ✓ Industrial design
- ✓ Engineering
- ✓ Mechanical (MCAD)

- ✓ Automotive
- ✓ Aerospace
- ✓ Machinery
- ✓ Building Engineering

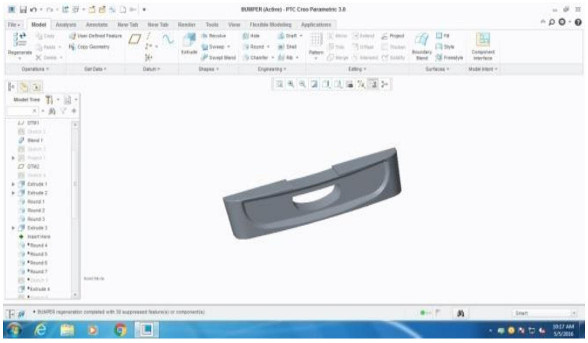
Pro E:

It is used to create model of the bumper

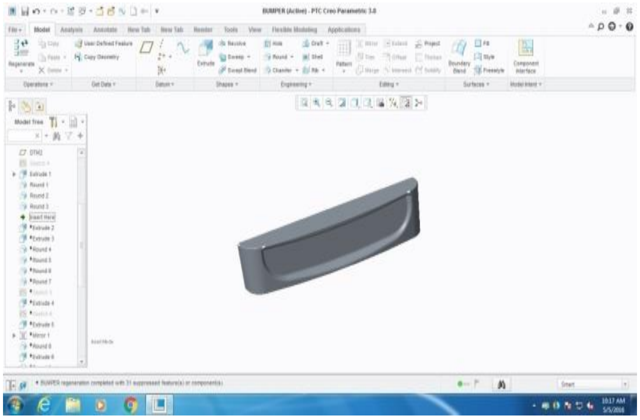
MODELS PREPARED



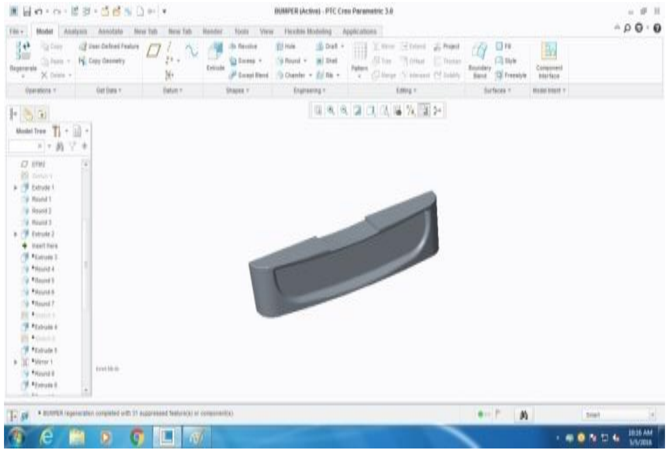
Modeling 1



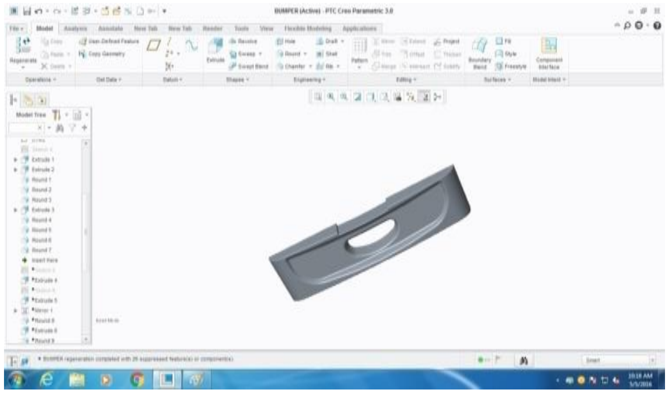
Modeling 2



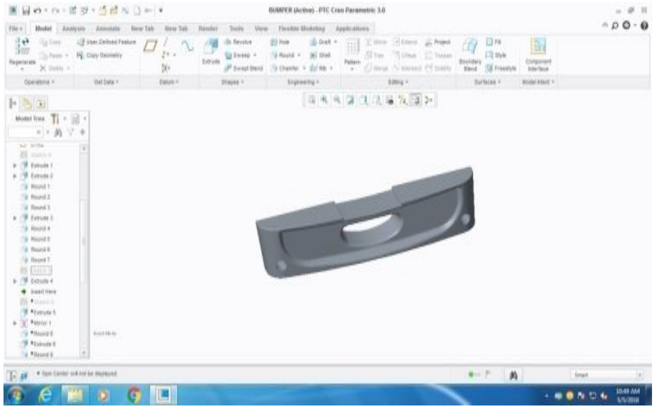
Modeling 3



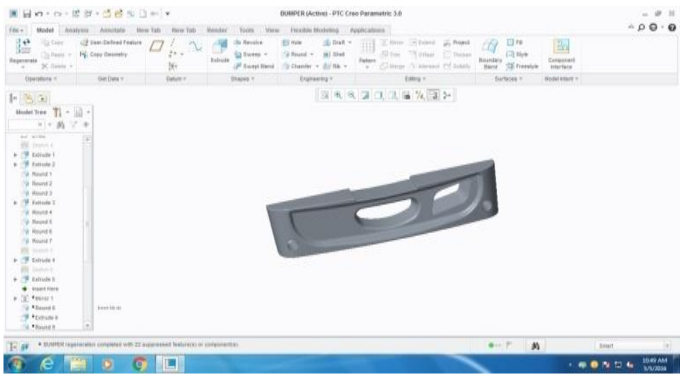
Modeling 4



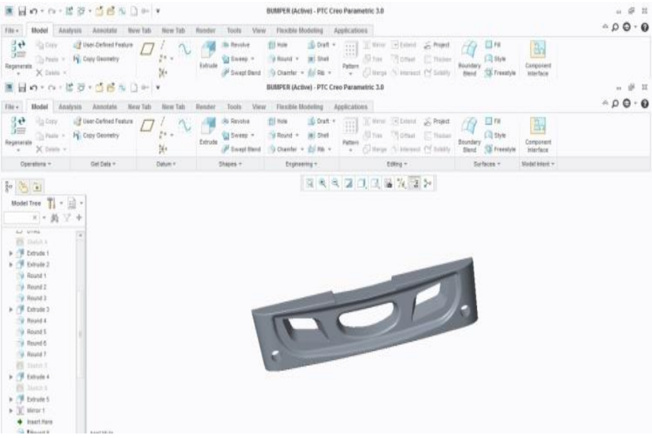
Modeling 5



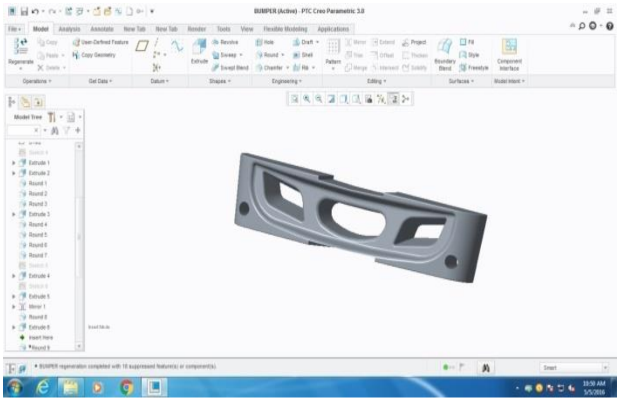
Modeling 6



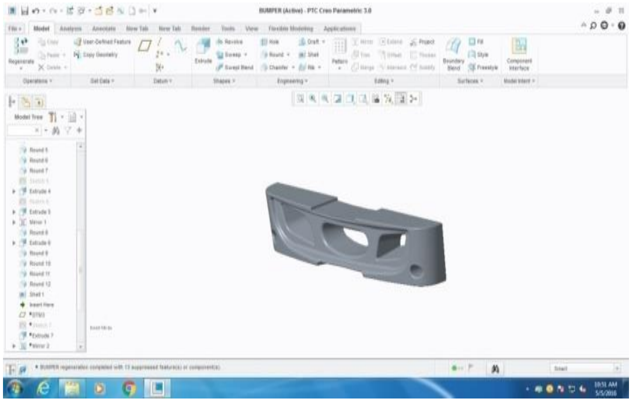
Modeling 7



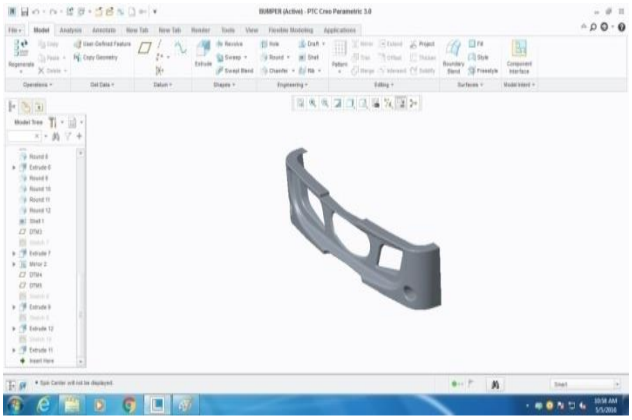
Modeling 8



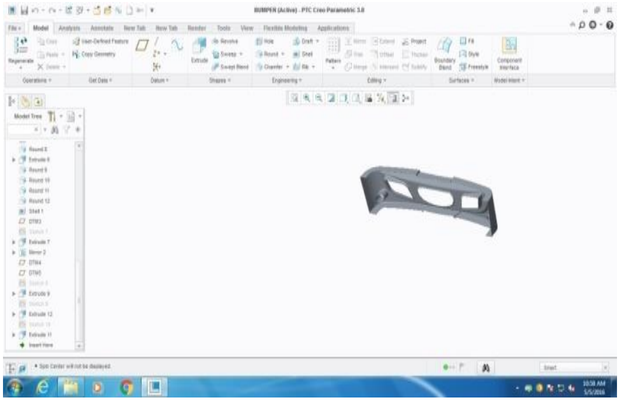
Modeling 9



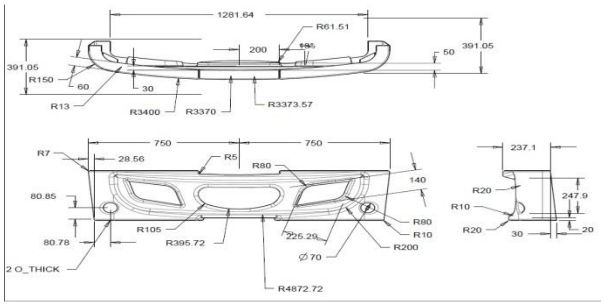
Modeling 10



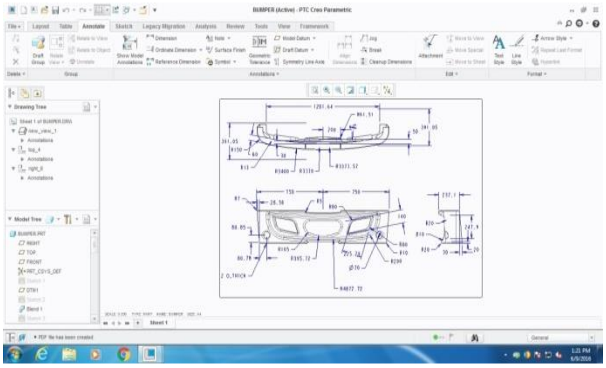
Modeling 11



Modeling 12



Modeling 13



Modeling 14

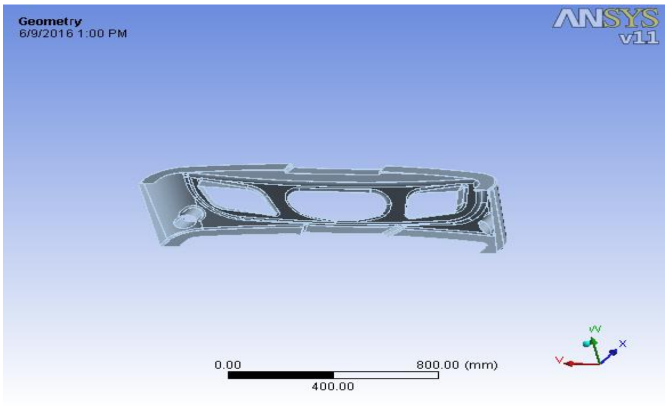
V. PROCEDURAL STEPS FOLLOWED IN ANSYS WORKBENCH

Structural Analysis

Importing the Model

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

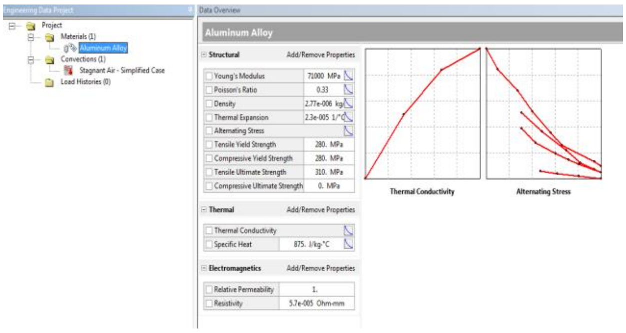
In utility menu file option and select import external geometry and open file and click on generate. To enter into simulation module click on project tab and click on new simulation.



Imported Geometry

Defining Material Properties

To define material properties for the analysis, following steps are used chose the main menu, select the model and create new material enter the properties again select simulation tab and select material.



Defining material properties

Defining Element Type

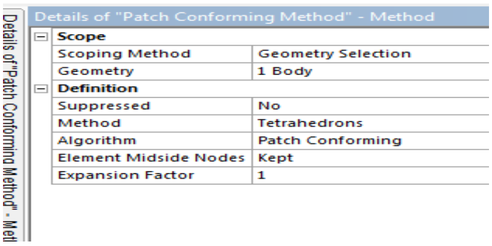
To define type of element for the analysis, these steps are to be followed:

Chose the main menu, select type of contacts and then click on mesh-right click-insert method

Method - Tetrahedrons

Algorithm - Patch Conforming

Element Midside Nodes – Kept



Details of "Patch Conforming Method" - Method

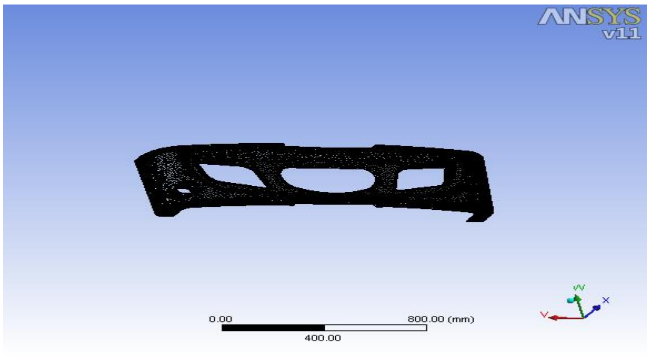
Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Suppressed	No
Method	Tetrahedrons
Algorithm	Patch Conforming
Element Midside Nodes	Kept
Expansion Factor	1

Defining element type

Meshing the model

To perform the meshing of the model these steps are to be followed:

Chose the main menu click on mesh- right click- insert sizing and then select geometry enter element size and then click on generate mesh.

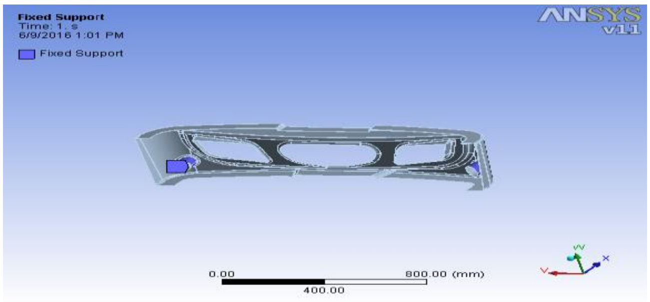


Meshing model

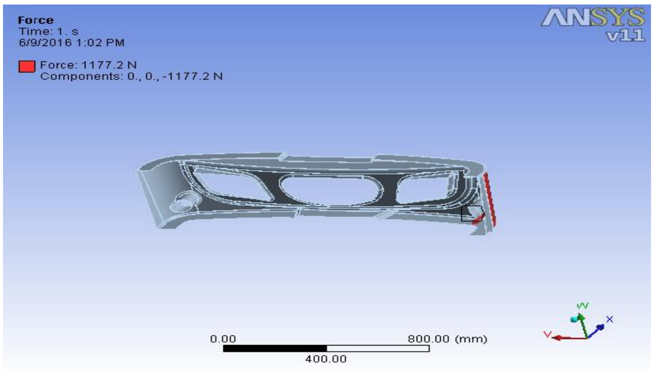
Applying Boundary conditions and Loads

To apply the boundary conditions on the model these steps are to be followed:

Chose the main menu, click on new analysis tab select static structural click on face and then select face of the geometry-right click- insert-fixed support. Choose the main menu, select face and click on face of geometry- right click – insert – force



Fixed supports



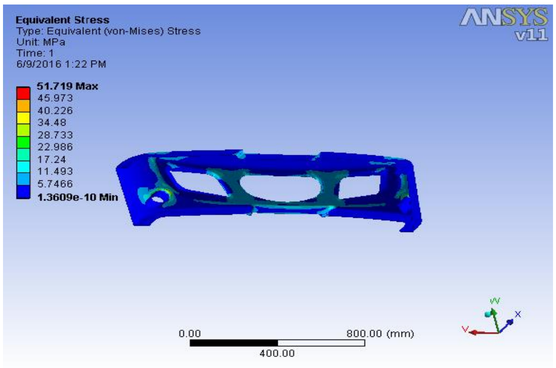
Force application

Aluminum B390 alloys Properties

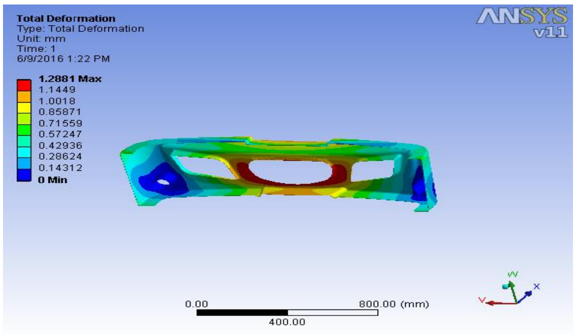
Static Structural Analysis

Young's Modulus	71000 MPa
Poisson's Ratio	0.33
Density	2.77e-006 kg/
Thermal Expansion	2.3e-005 1/°C
Alternating Stress	
Tensile Yield Strength	280. MPa
Compressive Yield Strength	280. MPa
Tensile Ultimate Strength	310. MPa
Compressive Ultimate Strength	0. MPa

Static Structural Analysis

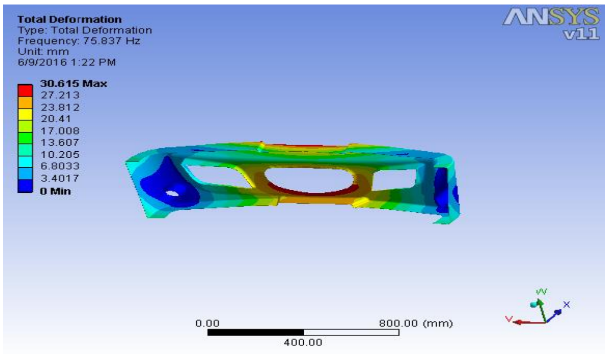


Equivalent stress

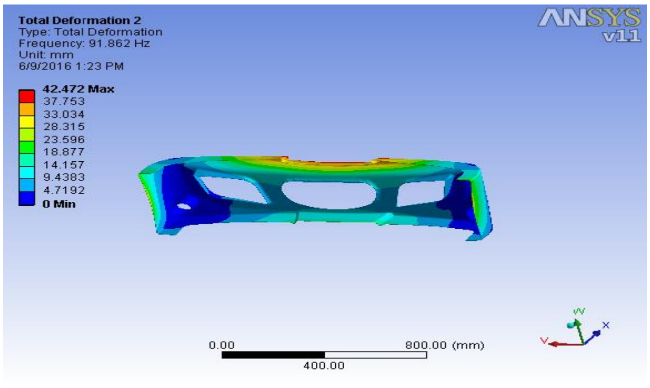


Total Deformation

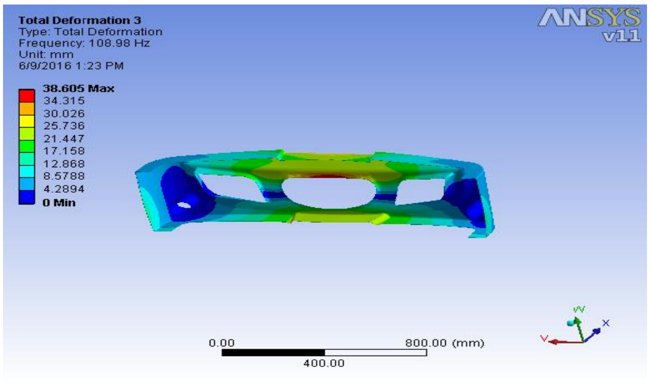
Model Analysis



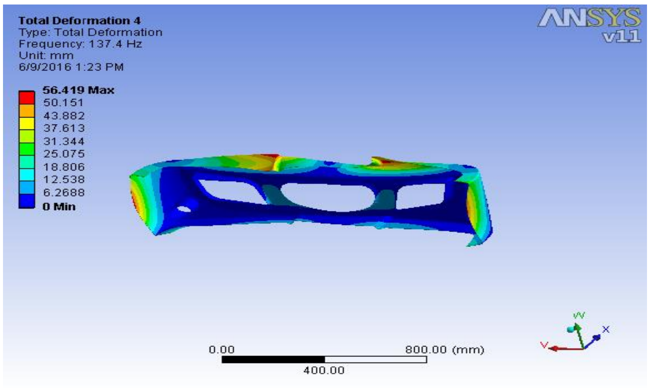
Mode 1



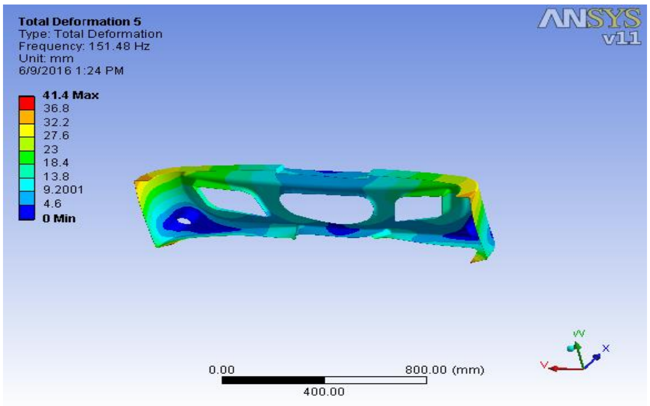
Mode 2



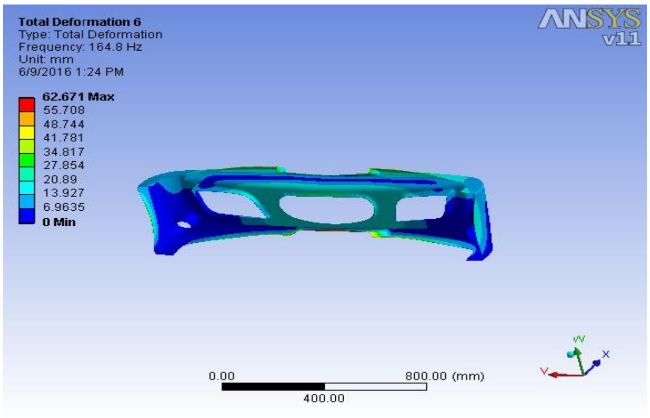
Mode 3



Mode 4



Mode 5



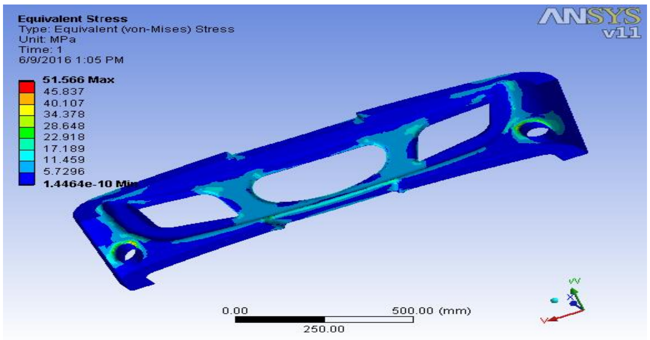
Mode 6

CARBON FIBER PROPERTIES

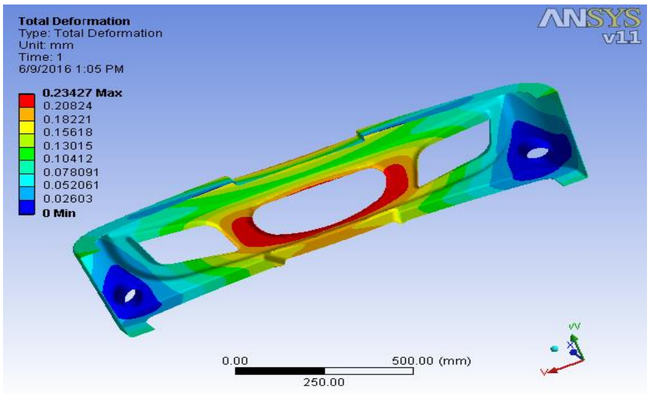
Static structural analysis

Young's Modulus	3.88e+005 MI
Poisson's Ratio	0.358
Density	1.6e-006 kg/r
Thermal Expansion	0.1 1/°C
Alternating Stress	

Carbon Fiber Properties

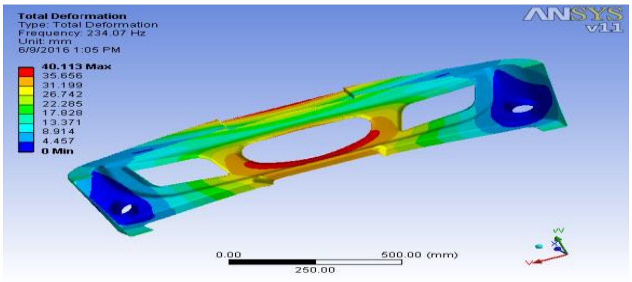


Equivalent stress

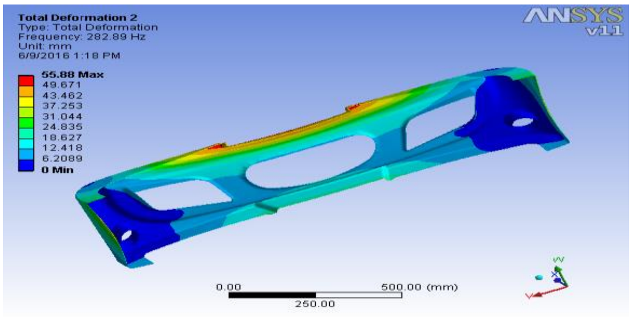


Total Deformation

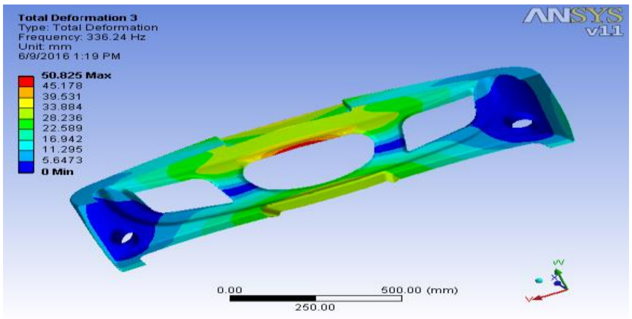
Modal Analysis



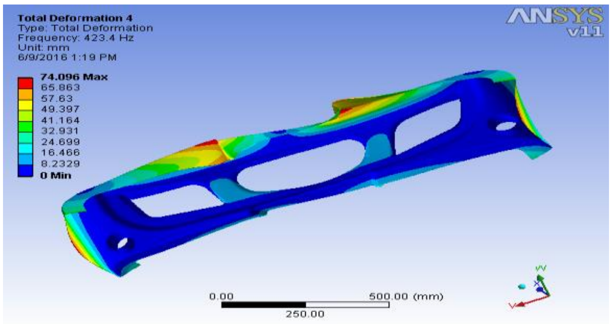
Mode 1



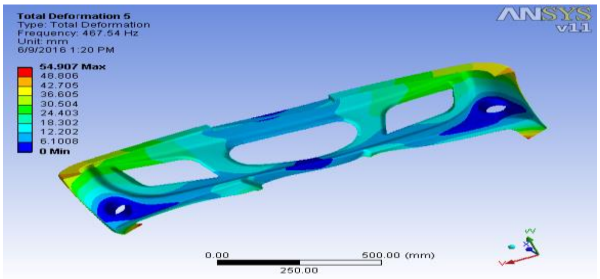
Mode 2



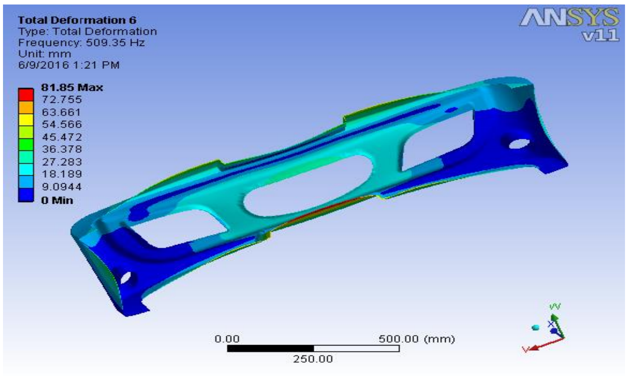
Mode 3



Mode 4



Mode 5



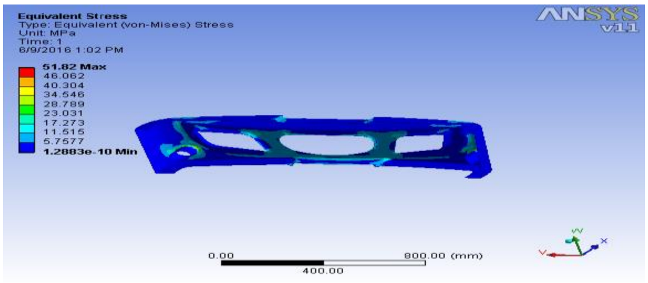
Mode 6

Chromium coated mild steel properties

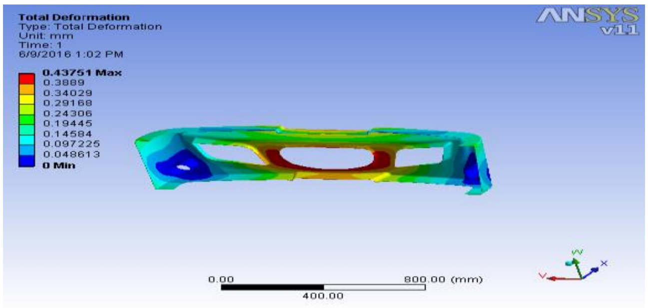
Young's Modulus	2.1e+005 MP
Poisson's Ratio	0.303
Density	7.85e+006 kg
Thermal Expansion	2.3e-005 1/°C
Alternating Stress	

Chromium coated mild steel properties

Static structural analysis

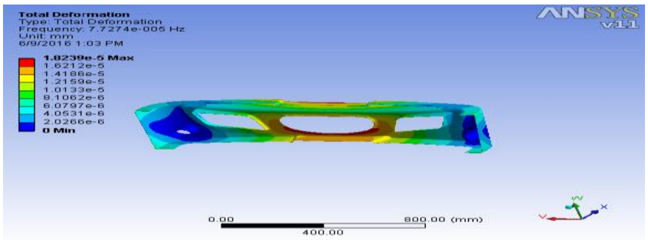


Equivalent stress

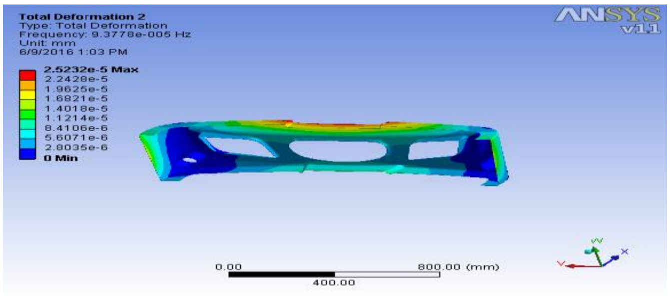


Total Deformation

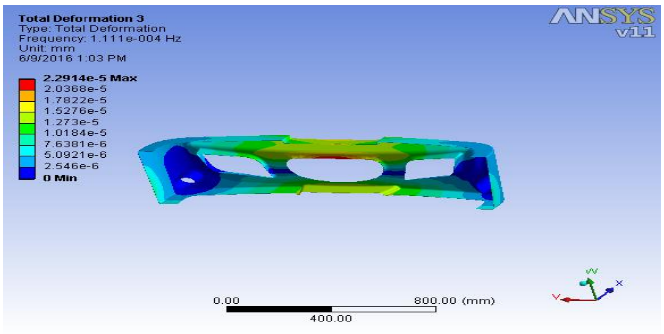
Modal Analysis



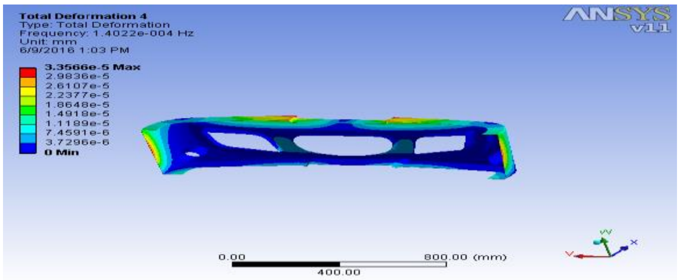
Mode 1



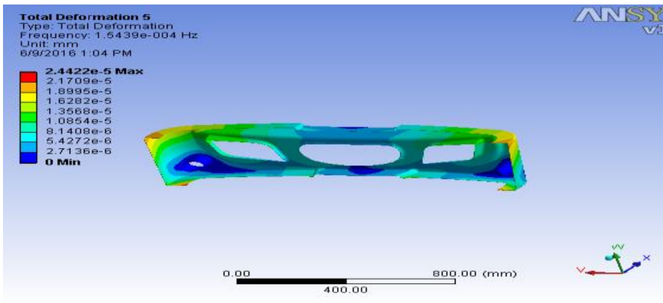
Mode 2



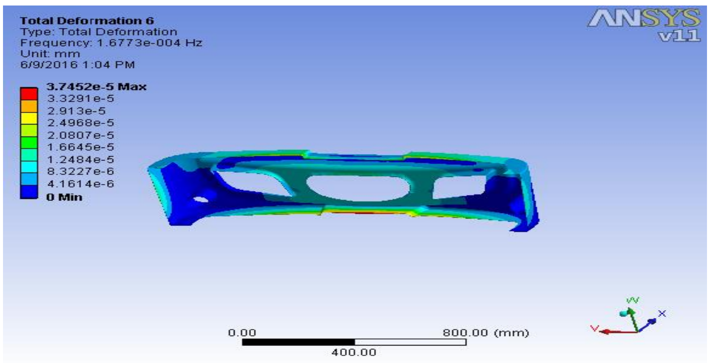
Mode 3



Mode 4



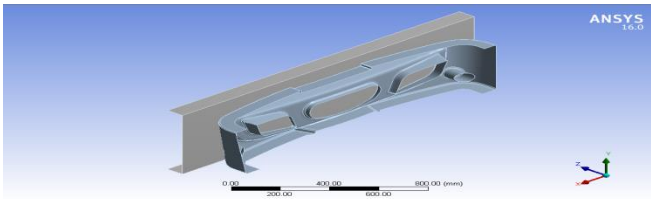
Mode 5



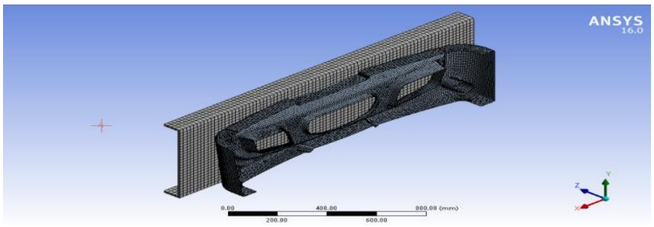
Mode 6

DYNAMIC ANALYSIS RESULTS

Material: Carbon Fiber

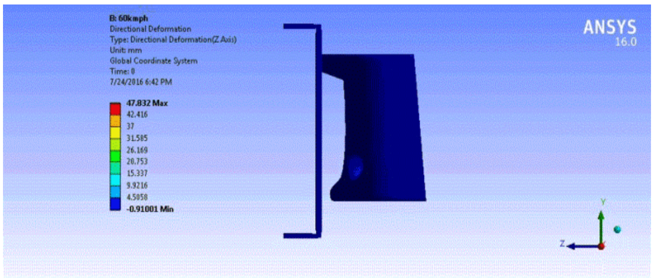


Geometry

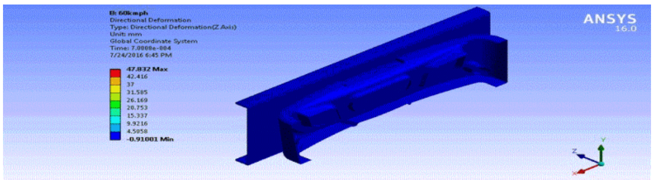


Messing part.

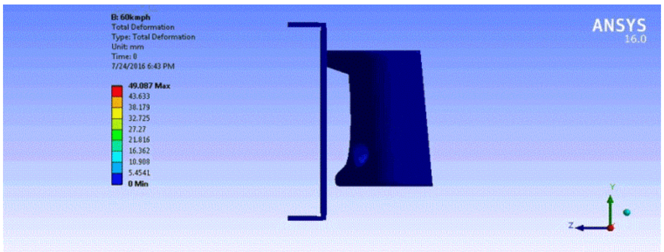
Statistics	
Nodes	13971
Elements	13498



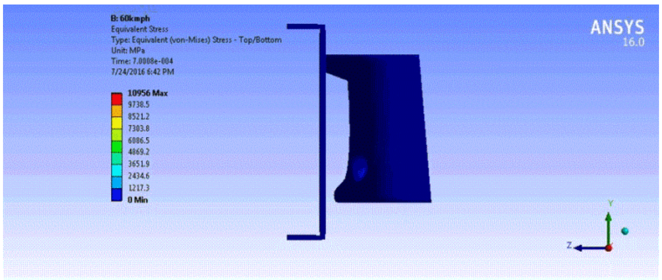
Directional Deformation-z Hitting Wall With 60 Km/Hr



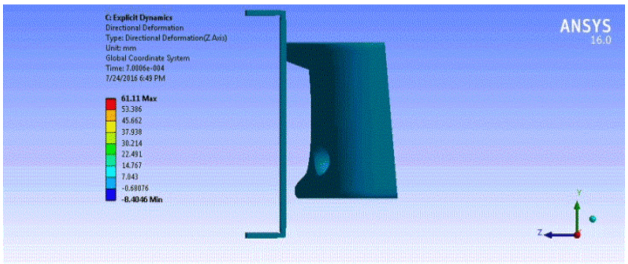
Directional Deformation-Z Hitting Wall With 60 Km/Hr



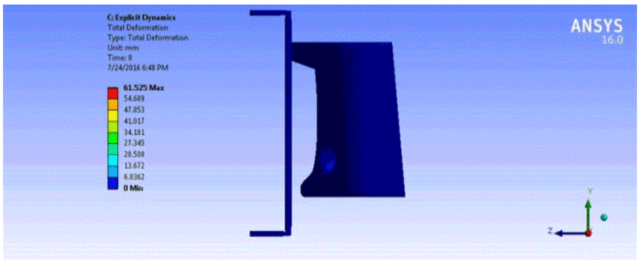
Total Deformation



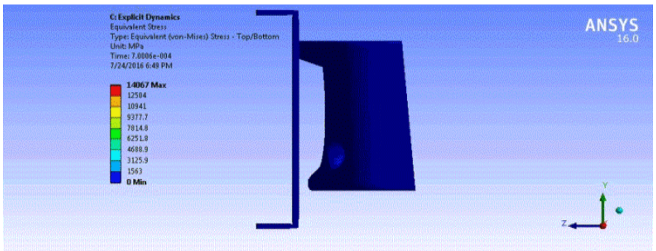
Equivalent stress



Directional Deformation-z Hitting Wall With80 Km/Hr

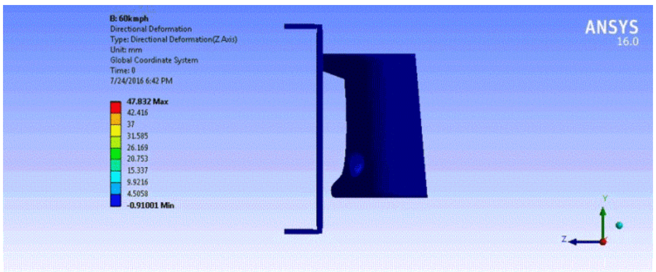


Total Deformation

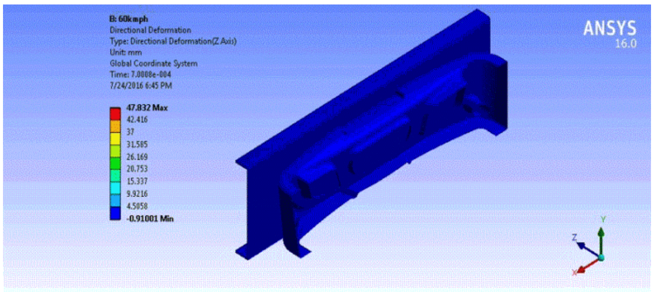


Equivalent stress

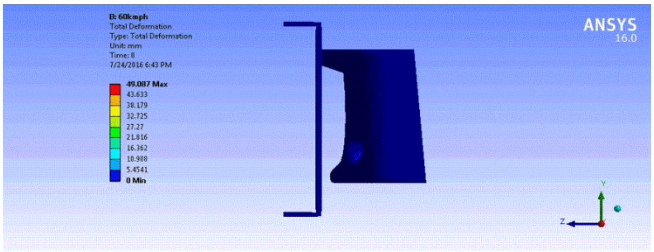
CHROMIUM COATED MILD STEEL



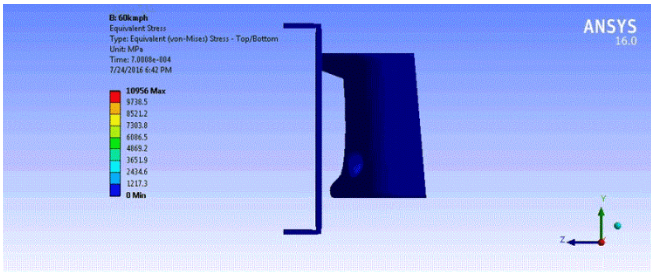
Directional Deformation-z Hitting Wall With 60 Km/Hr



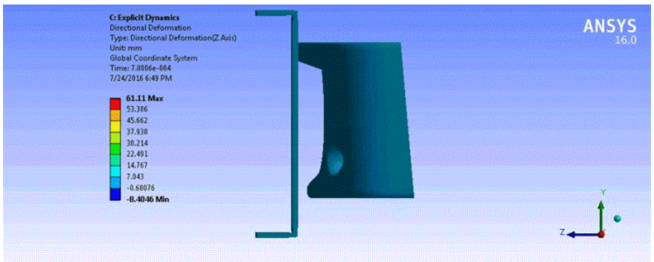
Directional Deformation-Z Hitting Wall With 60 Km/Hr



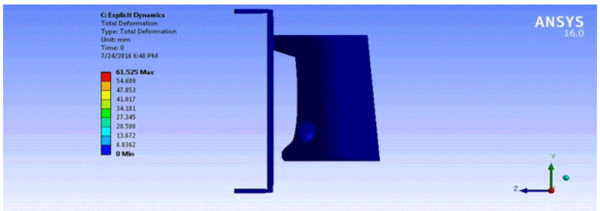
Total Deformation



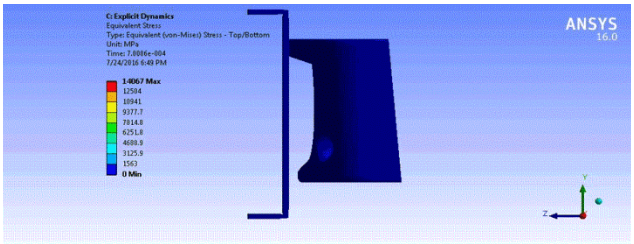
Equivalent stress



Directional Deformation-z Hitting Wall With80 Km/Hr

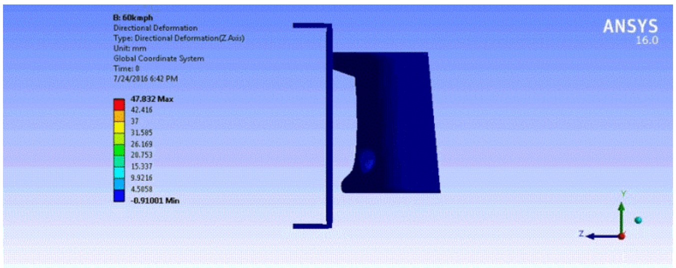


Total Deformation

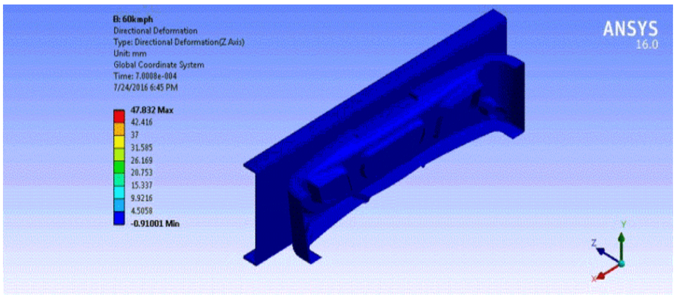


Equivalent stress

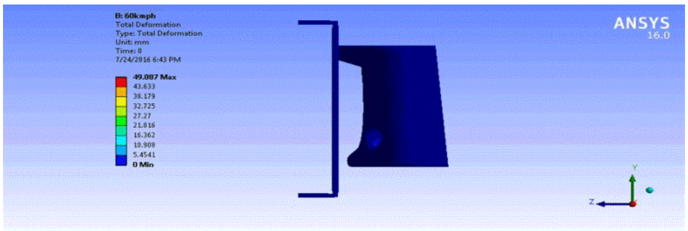
ALUMINUM B390 ALLOY



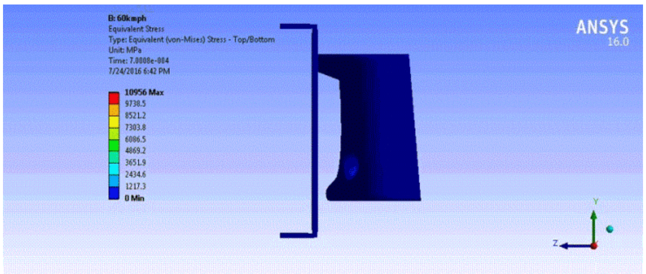
Directional Deformation-z Hitting Wall with 60 Km/Hr



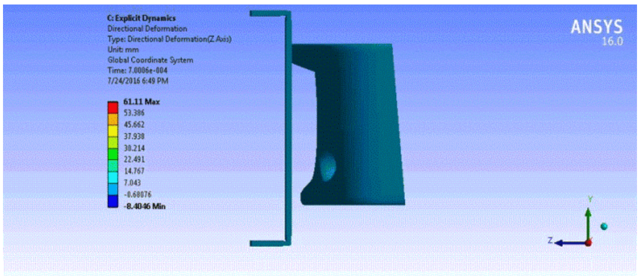
Directional Deformation-Z Hitting Wall With 60 Km/Hr



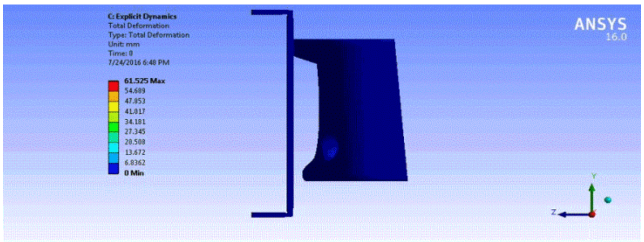
Total Deformation



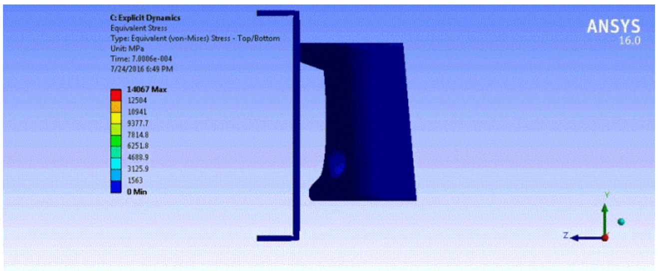
Equivalent stress



Directional Deformation-z Hitting Wall With80 Km/Hr



Total Deformation



Equivalent stress

VI. RESULTS

Materials	Equivalent stress(Mpa)	Total Deformation(mm)
Aluminum B390 alloy	51.719	1.2881
Carbon Fiber	51.566	0.23427
Chromium coated mild steel	51.82	0.43751

Total results

BEHAVIORS AT MODES

Mode	Aluminum B390 alloy		Carbon Fiber		Chromium coated mild steel	
	Frequency	Total deformation	Frequency	Total deformation	Frequency	Total deformation
Mode 1	75.837	30.615	234.07	40.113	7.727	1.8239
Mode 2	91.862	42.472	282.89	55.88	9.3778	2.2532
Mode 3	108.98	38.605	336.24	50.825	1.111	2.2914
Mode 4	137.4	56.419	423.4	74.096	1.44022	3.3566
Mode 5	151.48	41.4	467.54	54.907	1.5439	2.4422
Mode 6	164.8	62.671	509.35	51.85	1.677	3.7452

DYNAMIC ANALYSIS RESULTS

Material	Directional deformation -Z(mm)		Total deformation(mm)		Equivalent stress(Mpa)	
	60kmph	80kmph	60kmph	80kmph	60kmph	80kmph
Aluminum B390 alloy	52.853	70.256	55.236	71.258	13.569	15.231
Carbon Fiber	47.832	61.11	49.087	61.525	10.956	14.067
Chromium coated mild steel	53.004	74.186	55.452	72.125	13.145	16.021

Dynamic analysis results

VII.CONCLUSION

A mechanism is designed to convert about 80% of the kinetic impact energy to the spring potential energy and release it to the environment in the low impact velocity according to American standard. In addition, since the residual kinetic energy will be damped with the infinitesimal elastic deformation of the bumper elements, the passengers will not sense any impact. It should be noted that in this paper, modeling, and result's analysis are done in Pro-E and ANSYS software respectively. Carbon Fiber will give the better results and better protection for the four wheeler car bumper when compared with the other materials such as Aluminum B390 alloy and Chromium coated mild steel.

VIII. REFERENCES

[1]. Hosseinzadeh RM, Shokrieh M, and Lessard LB,"Parametric study od automotive composite bumper beams subjected to low-velocity impacts", J. CompositeStuct., 68 (2005):419-427.

[2]. Marzbanrad JM, Alijanpour M, and Kiasat MS, "Design and analysis of automotive bumper beam in low speed frontal crashesh", Thin Walled Struct., 47 (2009): 902-911.

[3]. Mohapatra S, "Rapid Design Solutions for Automotive Bumper Energy Absorbers using Morphing Technique",Altair CAE users Conference 2005, Bangalore, India.

[4]. Andersson R, Schedin E, Magnusson C, Ocklund J, "The Applicability of Stainless Steel for Crash Absorbing Components", SAE Technical Paper, 2002.

[5]. Butler M, Wycech J, Parfitt J, and Tan E, "Using Terocore Brand Structural Foam to Improve Bumper Beam Design", SAE Technical Paper, 2002,

[6]. Carley ME, Sharma AK, Mallela V, "Advancements in expanded polypropylene foam energy management for bumper systems", SAE Technical Paper, 2004.

[7]. Evans D and Morgan T, "Engineering Thermoplastic Energy for Bumpers", SAE Paper, 1999.

[8]. Witteman WJ, "Improved Vehicle Crashworthinessm Design by Control of the Energy Absorption for Different Collision Situations", Doctoral dissertation, Eindhoven University of Technology, 2000.

[9]. Masoumi A, Mohammad Hassan Shojaeefard, Amir Najibi, "Comparison of steel, aluminum and composite bonnet in terms of pedestrian

head impact"College of Engineering, University of Tehran, Tehran,Iran, 2011: 1371-1380.

[10]. Design Improvement In Front Bumper Of A Passenger Car Using Impact Analysis By Nitin S Motgi , International Journal of Instrumentation, Control and Automation (IJICA) ISSN: 2231-1890, Vol-1 Iss-3,4, 2012

[11]. Nitin S. Gokhale, Sanjay S. Despande, Dr. Anand N. Thite, "Practical Finite Element Analysis", Finite To Infinite, India, 2007.

[12]. Carley ME, Sharma AK, Mallela V, "Advancements in expanded polypropylene foam energy management for bumper systems", SAE Technical Paper, 2004.

[13]. Evans D and Morgan T, "Engineering Thermoplastic Energy for Bumpers", SAE Paper, 1999.

[14]. A Review on the Composite Materials used for Automotive Bumper in Passenger Vehicles by Alen John Vol-4, Issue-4, August-2014, ISSNNo.:2250-0758 International Journal of Engineering and Management Research,pg.no.98-101.

[15]. Comparative analysis of frontal car bumper during impact by Bhavesh A. Bohra, IJAIEM ,Volume 3, Issue 12, December 2014 ISSN 2319 - 4847

[16]. Crash Analysis of Car Cross Member Bumper Beam by Dr. A. Srinath, altair technology conference , K L University

[17]. Zonghua Zhang, Shutian Liu, Zhiliang Tang, "Design optimization of cross-sectional configuration of ribreinforced thin-walled beam" Dalian University of Technology, Dalian, China. 2009.PP 868-878.

Cite this article as :

R Sreekantha Reddy, C Raghunath Reddy, "Design and Analysis of An Automotive Bumper", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 7 Issue 1, pp. 114-131, January-February 2020.

Journal URL : http://ijsrst.com/IJSRST1207133