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Impact Analysis of Front Frame Car Bumper

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ABSTRACT

Bumpers play an important role in preventing the impact energy from being transferred to the automotive and a passenger, saving impact energy on the bumper to be released in the environment reduces the damages of the automotive and passengers.

The new design considers on reducing the amount of material use and also eliminating the process involve in manufacture the bumper for example eliminating the grille attachment. The goal of this project is to design a bumper with minimum weight by employing the composite materials (just like glass fibre epoxy materials). This bumper either absorbs deformation or transfers it perpendicular to the impact direction. To reach this aim, a mechanism is designed to convert above 80% of kinetic impact energy is to the spring potential energy. In addition, since the residual kinetic energy will be damped with infinitesimal elastic deformation of the bumper elements, the passengers will not sense any impact, it should be noted in this project modeling, solving and results are analysis are done in a ANSYS software respectively.

The suitable material that can be used as the bumper in terms of economical but still maintaining the toughness is Carbon Fiber composite which is not expensive compare to the best material from the analysis Aluminum alloy, Mild steel(chromium Coated).

Keywords: Bumper, Cati A, Ansys,

Introduction

One of the inevitable consequences of the use of automobiles is that from time to time accidents will cause damage to a vehicle's body. Over the years, many new materials have been introduced to the car body. Composite car bumper also implied the same problem which the material will be discussed further in this project.

Objectives

The objectives of this project are:

(a) To design a composite car bumper by using CATIA.
(b) To perform an impact analysis of composite car bumper by using Ansys
(c) To propose a suitable composite material for the car bumper.

Scope of the research.

This project has been confined to five relatively simple aspects which they are:

(b) Literature study on composite car bumper (the fascia bumper)
(c) Implementing knowledge of software (CATIA) in design.
(d) Learning and exploring in a way to use Ansys software
(e) Perform an Structure and Thermal analysis of bumper material by using Ansys software.
(f) Purposing a suitable composite material for commercial front bumper.

Theory of composite material

Definition

Composite materials or simply composites are combinations of materials. They are made up of combining two or more materials in such a way that the resulting materials have certain design properties or improved properties. The composite materials have the following properties.

- High specific strength
- High specific stiffness
- More thermal stability

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- More corrosion and wear resistance
- High fatigue life

CLASSIFICATION OF COMPOSITE MATERIALS

Based upon the reinforcements, the composite materials are classified as fiber reinforced composite, filled composite, flake composite, particulate composites and laminates. The fiber composites can be further classified as whisker composites and continuous fiber composites. Based upon the matrix, composite materials are classified as metal matrix composites, polymer matrix composites and ceramic matrix composites.

Application of Loads

The calculation of the load is given as follows.

1) Input data:

Mass of the car =1554 kg

Average mass of 5 persons =350 kg

Total mass =1554+350

=1894 kg

Speed of the car =36 km/hour

=10 m/s.

Assume this car is hitting at another identical one and it will stop in 0.1 seconds

Deceleration of the car =(u+v) / t

= (10-0)/0.1

= 100 m/s^2

v= final velocity of car in m/s, u = initial velocity ofcar in m/s, t=time after which vehicle stopped inseconds.

Force acted during collision =m*a

=1894*100

= 189.4 KN

m= mass of car in kg , a = acceleration of car in m/s^2

Area of the front face of bumper =l*b

=2317.75*641.096mm^2

=1.4859m^2

Pressure acted on the bumper =F/A

=189400/1.4859

=127.46*10^3N/m^2

F= Force acted during collision in Newtons, A = Area of the front face of bumper in m^2.

Aluminium B390 alloy Material Properties Table -2

Density	2.71e-006 kg mm^-3

Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	81300	0.33	79706	30564

Tensile Yield Strength

Tensile Yield Strength MPa
2.5e-004

Mild steel Material Properties

Mild steel (chromium coated) Material Properties Table -3

Density	7.8e-006 kg mm^-3

Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	2.1e+005	0.3	1.75e+005	80769

Tensile Yield Strength

Tensile Yield Strength MPa
3.e-004

Carbon fiber composite Material Properties Table-4

Density	1.6e-006 kg mm^-3

Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	85000	0.15	40476	36957

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Aluminium B390 alloy Material Properties Table -5

Density	2.71e-006 kg mm^-3
Thermal Conductivity	0.3 W mm^-1 C^-1
Specific Heat	4.8e+005 mJ kg^-1 C^-1

Isotropic Elasticity

Temperatur e C	Young's Modulu s MPa	Poisson' s Ratio	Bulk Modulu s MPa	Shear Modulu s MPa
	81300	0.33	79706	30564

Tensile Yield Strength

Tensile Yield Strength M
2.5e-004

Mild steel Material Properties

Mild steel (chromium coated) Material Properties Table-6

Density	7.8e-006 kg mm^-3
Thermal Conductivity	0.3 W mm^-1 C^-1
Specific Heat	4.8e+005 mJ kg^-1 C^-1

Isotropic Elasticity

Temperatu re C	Young's Modulu s MPa	Poisson' s Ratio	Bulk Modulus MPa	Shear Modulu s MPa
	2.1e+00 5	0.3	1.75e+00 5	80769

Tensile Yield Strength

Tensile Yield Strength MPa
3.e-004

Carbon fiber composite Material Properties Table-7

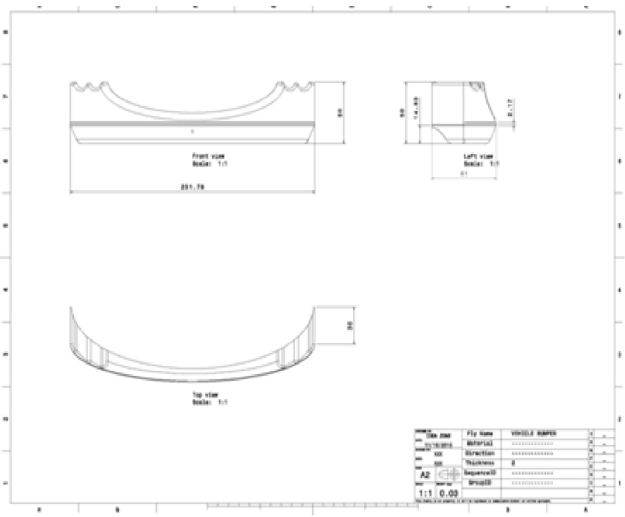
Density	1.6e-006 kg mm^-3
Specific Heat	1.83e+005 mJ kg^-1 C^-1
Thermal Conductivity	0.33 W mm^-1 C^-1

Isotropic Elasticity

Temperatur e C	Young's Modulu s MPa	Poisson' s Ratio	Bulk Modulu s MPa	Shear Modulu s MPa
	85000	0.15	40476	36957

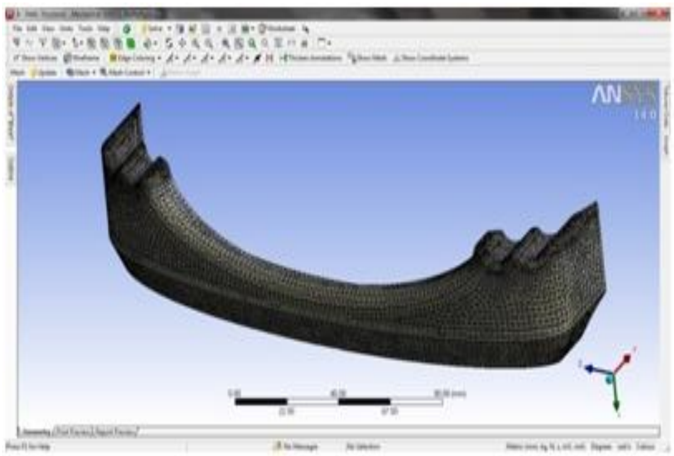
Tensile Yield Strength

Tensile Yield Strength MPa
3.e-004



Dimension of the bumper

Statistics	
Nodes	114048
Elements	71946
Mesh Metric	None



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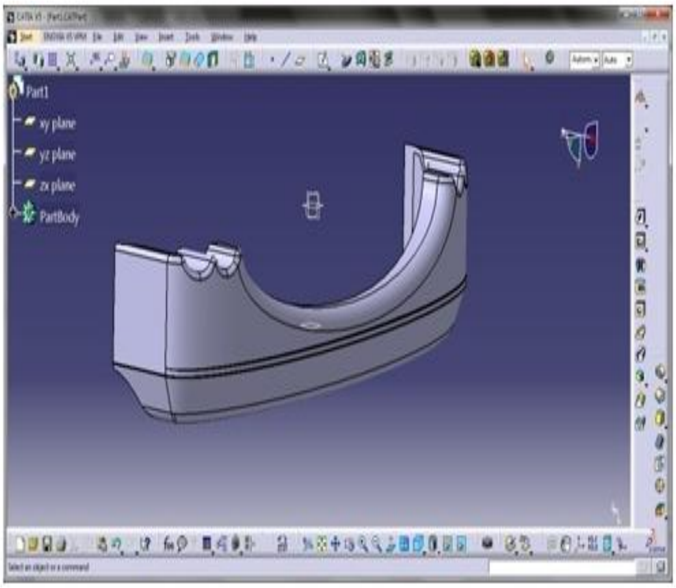
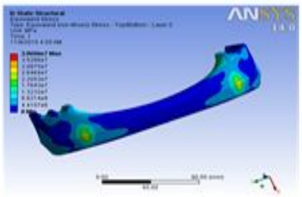
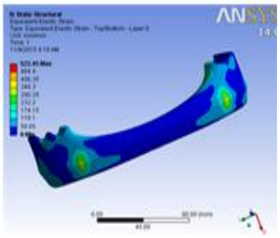
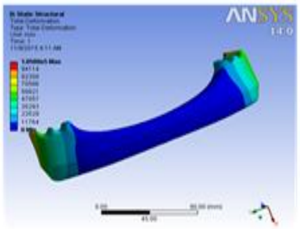


Modeling of bumper with CATI A

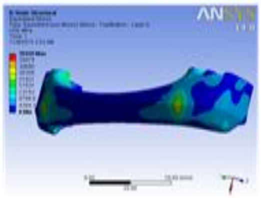
Total Deformation and stress ,strain with alluminium alloy Material

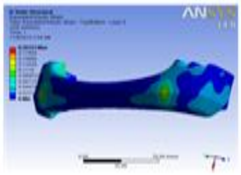


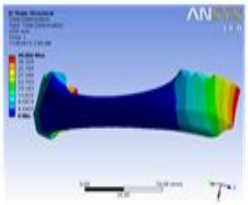




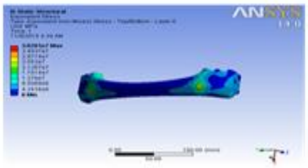
Total Deformation and stress ,strain with Mild Steel (chromomum Coated) Material

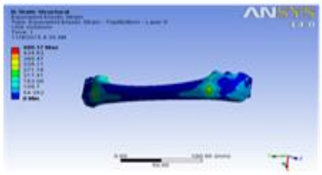


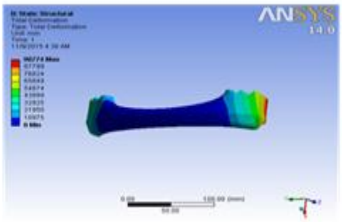




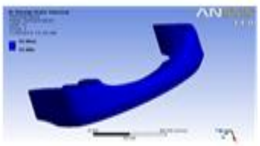
Total Deformation and stress ,strain with Carbon Fiber composite Material

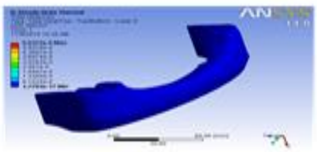


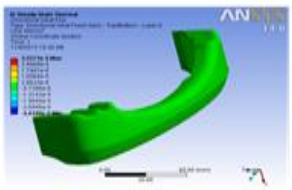




Temperature is applied on the outer surface of the bumper. Temperature applied is 45. ° on the bumper. Total Heat Flux ,directional Heat flux With Alluminium alloy







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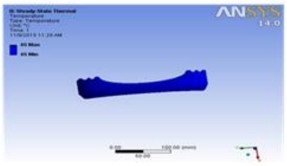
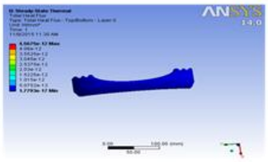
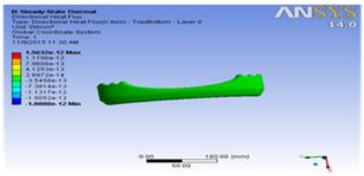
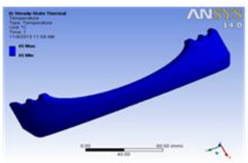
Temperature is applied on the outer surface of the bumper. Temperature applied is 45. ° on the bumper. Total Heat Flux,directional Heat flux With Mild steel(Chromimum)Coated Material

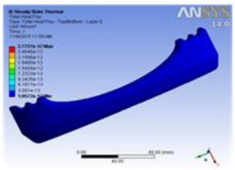


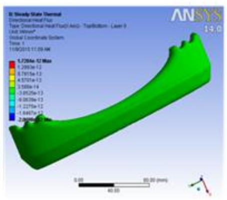




Temperature is applied on the outer surface of the bumper. Temperature applied is 45. ° on the bumper. Total Heat Flux, directional Heat flux With Composite Fiber composite Material







BUMPER / RESULTS	Mild steel (chromium coated)		Aluminium B390 alloy		Carbon fiber composite	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Total Deformation mm	0	40.866	0	$1.05x10^5$	0	98774
Equivalent Stress M pa	0	39459	0	$3.8216x10^7$	0	$3.8281x10^7$
Equivalent Elastic Strain mm/mm	0	0.20143	0	522.45	0	489.17

BUMPER / RESULTS	Mild steel (chromium coated)		Aluminium B390 alloy		Carbon fiber composite	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Temperature °C	45	45	45	45	45	45
Total Heat Flux W/mm²	1.7793e-017	4.5675e-012	1.7793e-017	5.5372e-005	1.9572e-017	2.7727e-012
Directional Heat Flux W/mm²	-1.8888e-012	1.5632e-012	-3.4348e-005	3.2271e-005	-2.0698e-012	1.7204e-012

CONCLUSION

In order to design the front bumper, the following factors are to be considered

1. Material having high yield strength high modulus of elasticity is to be considered.
2. Deformation of the bumper material during low speed mode is not considered.
3. Maximum deformation during the high speed is considered while designing that to within the acceptable limit.
4. Tensile yield stress consider of the material is less than maximum stress of the bumper

From the above study it can conclude that for carbon fiber composite is better option compare to Mild steel and alluminium alloy

Future scope

The project is applicable to aluminum alloy, Mild steel (chromium coated) and carbon Fiber composite. Carbon Fiber composite is more useful better than two materials, but cost is high. Normally carbon Fiber composite is used for sports cars for less damage. The project is done based on the impact analysis on front frame car bumper. If sudden impact load is applied, relatively the collisions are less in the vehicles.

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