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MODELLING AND ANALYSIS OF A CAR BUMPER USING VARIOUS MATERIALS BY FEA SOFTWARE

R.Ranjithkumar[1], J.P.Ramesh[2]

Department of Mechanical Engineering, Valliammai Engineering College,Kattankulathur

***Corresponding author: Email: Ranjithmecadcam@gmail.com**

ABSTRACT

Bumper is an important part which is used as protection for passengers from front and rear collision. The intend of this study was to investigate the structure and material employed for car bumper in one of the car manufacturer. In this study, the most important variables like material, structures, shapes and impact conditions are studied for analysis of the bumper beam in order to improve the crashworthiness during collision.The simulation of a bumper is characterized by impact modeling using Pro/Engineer, impact analysis is done by SOILD WORKS according to the speed that is 13.3 m sec-1 (48 km h-1) given in order to analyze the results. This speed is according to regulations of Federal Motor Vehicle Safety Standards, FMVSS 208- Occupant Crash Protection whereby the purpose and scope of this standard specifies requirements to afford impact protection for passengers. In this research, analysis is done for speed according to regulations and also by changing the speeds. Simulation using Finite Element Analysis software, which is SOILD WORKS, was conducted. The material used for bumper is ABS Plastic ands2 Glass Epoxy.

Keywords: Pro-E, meshing, bumper, stress, displacement, strain

INTRODUCTION

An automobile's bumper is the front-most or rear-most part, ostensibly designed to allow the car to sustain an impact without damage to the vehicle's safety systems. They are not capable of reducing injury to vehicle occupants in high-speed impacts, but are increasingly being designed to mitigate injury to pedestrians struck by cars. Front and rear bumpers became standard equipment on all cars in 1925. What were then simple metal beams attached to the front and rear of a car have evolved into complex, engineered components that are integral to the protection of the vehicle in low-speed collisions. Today's plastic auto bumpers and fascia systems are aesthetically pleasing, while offering advantages to both designers and drivers. The majority of modern plastic car bumper system fascias are made of thermoplastic olefins (TPOs), polycarbonates, polyesters, polypropylene, polyurethanes, polyamides, or blends of these with, for instance, glass fibers, for strength and structural rigidity.

The use of plastic in auto bumpers and fascias gives designers a tremendous amount of freedom when it comes to styling a prototype vehicle, or improving an existing model. Plastic can be styled for both aesthetic and functional reasons in many ways without greatly affecting the cost of production. Plastic bumpers contain reinforcements that allow them to be as impact-resistant as metals while being less expensive to replace than their metal equivalents.

Plastic car bumpers generally expand at the same rate as metal bumpers under normal driving temperatures and do not usually require special fixtures to keep them in place.This enables the manufacturer to reuse scrap material in a cost-effective manner. A new recycling program uses painted TPO scrap to produce new bumper fascias through an innovative and major recycling breakthrough process that removes paint from salvage yard plastic. Tests reveal post-industrial recycled TPO performs exactly like virgin material, converting hundreds of thousands of pounds of material destined for landfills into workable grade-A material, and reducing material costs for manufacturers. Why has bumper effectiveness been reduced in preventing damage in a minor collision? One reason could be that statutory bumper standards were made quite loose. As a result, many of today's bumpers allow cars to be damaged more easily.

TYPES OF BUMPER

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.

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.

Carbon fiber bumper: Carbon fiber body work is normally the thing of super-cars, but many a car companies, and specialist modifiers, are starting to use it for replacement body part on everyday cars.

Steel bumper: Originally plated steel was used for the entire body of a car and including of the bumper. This material worked well, as it was very strong in a crash, but it was the 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.

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DESIGN OF CAR BUMPER BY PRO-E SOFTWARE

Pro/Engineer is a software application within the CAID/CAD/CAM/CAE category, along with other similar products currently on the market. Pro/Engineer is a parametric, feature-based modeling architecture incorporated into a single database philosophy with advanced rule-based design capabilities. The capabilities of the product can be split into the three main heading of Engineering Design, Analysis and Manufacturing. This data is then documented in a standard 2D production drawing or the 3D drawing standard ASME Y14.41-2003. Modeling of car bumper is done with help of Pro-e software and dimensions are selected from one of car bumper. As the impact is more for the front portion of bumper only outer dimensions of car bumper has been considered for modeling, Slots provided in middle of car bumper is used for reducing drag effect in car bumper.

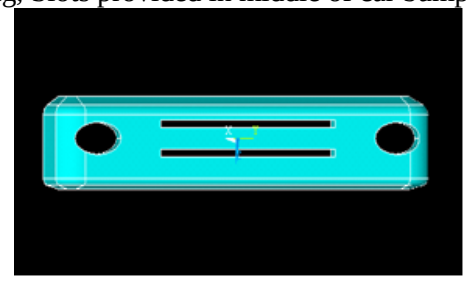

Fig.1.Model Of a Car Bumper

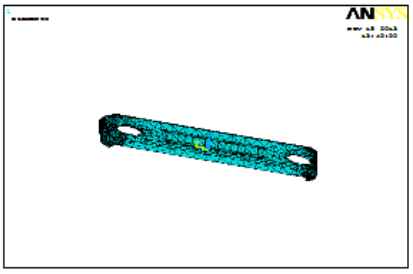

Fig.2.Meshing Of Car Bumper

Analysis of car bumper with FEA software: Cosmos works is useful software for design analysis in mechanical engineering. That's an introduction for you who would like to learn more about COSMOS Works. COSMOS Works is a design analysis automation application fully integrated with Solid Works. This software uses the Finite Element Method (FEM) to simulate the working conditions of your designs and predict their behavior. FEM requires the solution of large systems of equations. Powered by fast solvers, COSMOS Works makes it possible for designers to quickly check the integrity of their designs and search for the optimum solution.

A product development cycle typically includes the following steps: 1 Build your model in the Solid Works CAD system 2 Prototype the design. 3 Test the prototype in the field.4 Evaluate the results of the field tests. 5 Modify the design based on the field test results. Analysis Steps: You complete a study by performing the following steps: Create a study defining its analysis type and options. If needed, define parameters of your study. Parameters could be a model dimension, a material property, a force value, or. Analysis Background: Linear Static Analysis Frequency Analysis Linear zed Buckling Analysis Thermal Analysis Optimization Studies, Material property, Material Models, Linear Elastic Isotropic, Plotting Results, Describes how to generate a result plot and result tools. Listing Results, Overview of the results that can be listed, Graphing Results, Shows you how to graph results, Results of Structural Studies, Lists results available from structural studies, Results of Thermal Studies. Lists results available from thermal studies, Reports, explains the study report utility. Stress Check.

Meshing of car bumper:

Table.1.Setup Information

Type	Velocity at impact
Velocity Magnitude	13.333m/sec
Impact Velocity reference	Face<1>
Gravity	9.81m/s^2
Gravity reference	Face<2>
Parallel of reference plane	Plane1
Friction coefficient	0
Target stiffness	Rigid target
Critical Damping Ratio	0

Table.2.Units

Unit System	SI(MKS)
Length/Displacement	mm
Temperature	Kelvin
Angular velocity	Rad/Sec
Pressure	N/m^2

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Material Properties ABS Plastic

Name : ABS Plastic
Model Type : Linear Elastic Isotropic
Default failure : Max Von Mises Stress
Elastic modulus : 2e+009N/m^2
Tensile Strength : 3e+007N/m^2
Poisson's ratio : 0.394
Mass Density : 1020Kg/m^3
Shear modulus : 3.189e+008N/m^2

For Speed 40Km/hr ABS Plastic

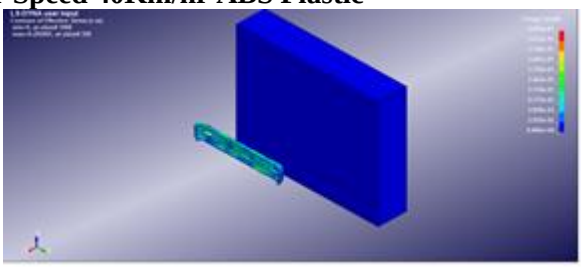

Fig.3.Bumper-40-per-Stress-Stress

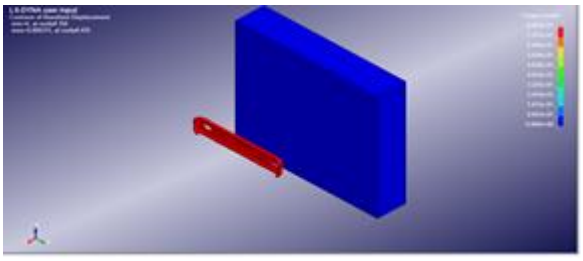

Fig.4.Bumper-40-per-Displacement-Displacement

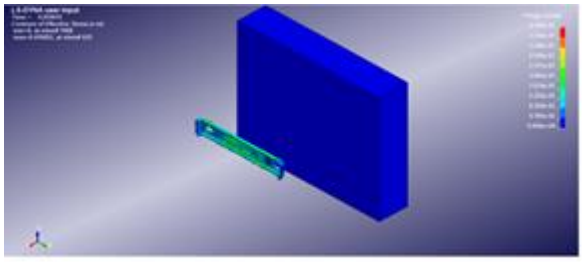

Fig.5.Bumper-40-per-Strain-Strain

For Speed 60Km/hr ABS Plastic

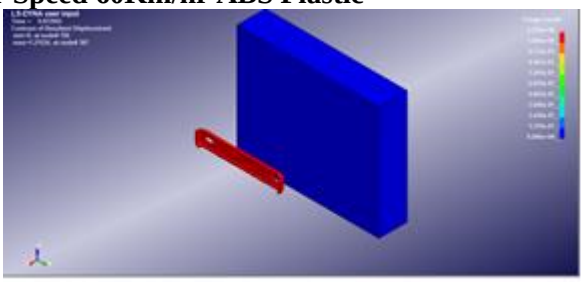

Fig.6.Bumper-60-per- Stress-Stress

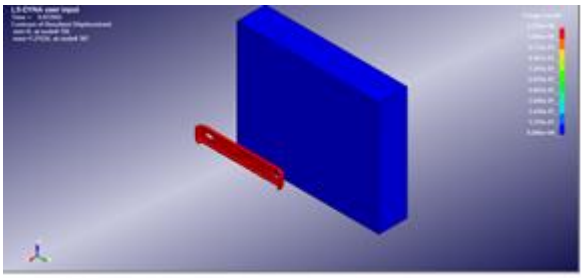

Fig.7.Bumper-60-per-Displacement-Displacement

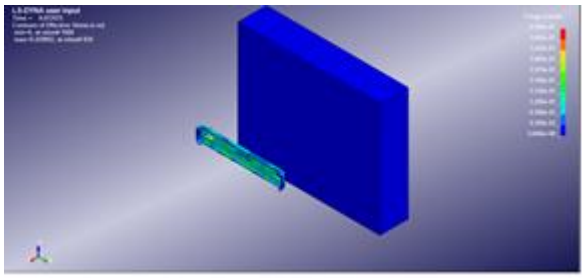

Fig.8.Bumper-60-per-Strain-Strain

Material Properties S2 GLASS

Name : S2 GLASS
Model Type :Linear Elastic Isotropic
Default failure :Max Von Mises Stress
Elastic modulus :8.69e+010N/m^2
Yield Strength :4.89e+009N/m^2
Poisson's ratio :0.23

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Mass Density :2460Kg/m^3
Shear modulus :3.189e+008N/m^2

For Speed 40Km/hr S2 Glass Epoxy

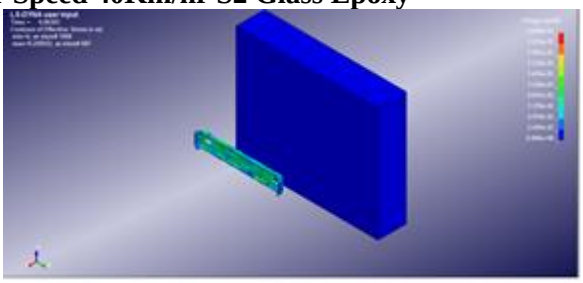

Fig.9.Bumper-40-per-Stress-Stress

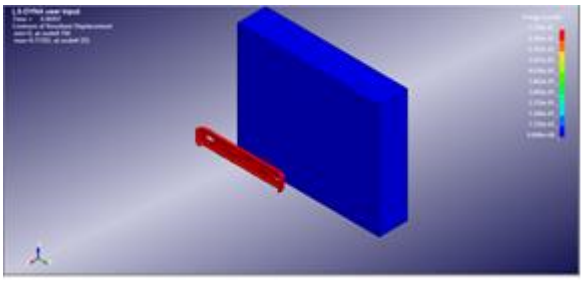

Fig.10.Bumper-40-per-Displacement-Displacement

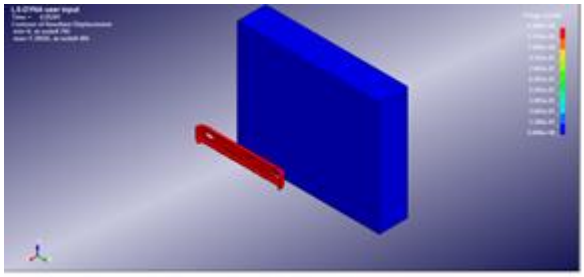

Fig.11.Bumper-40-per-Strain-Strain

For Speed 60Km/hr S2 Glass Epoxy

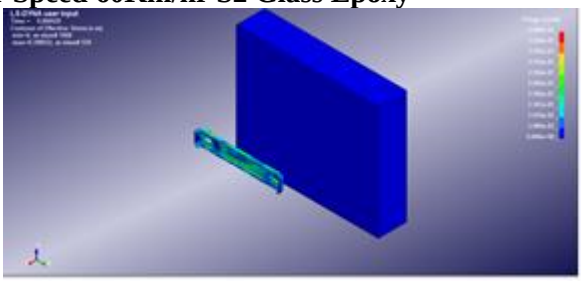

Fig.12.Bumper-60-per- Stress-Stress

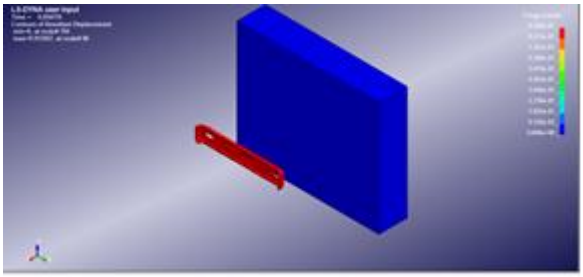

Fig.13.Bumper-60-per-Displacement-Displacement

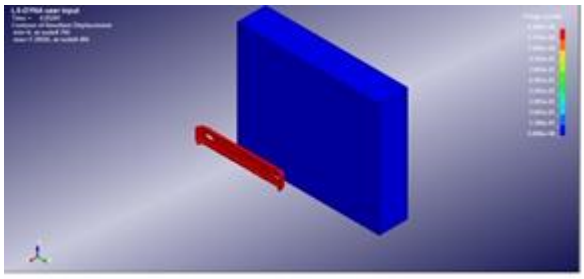

Fig.14.Bumper-60-per-Strain-Strain

RESULTS AND DISCUSSIONS

Observing the graphs of stress and Displacement, valves of ABS Plastic are less than S2 Glass Epoxy, The ABS Plastic has good impact resistance when compared to S2 Glass Epoxy.

Table.3.

Material	Speed	STRESS N/mm2	Displacement mm	Strain
ABS Plastic	40Km/hr	39.6692	0.353701	0.00896028
	60Km/hr	49.680	0.884905	0.00128960
S2 GLASS Epoxy	40Km/hr	264.793	0.382953	0.00696028
	60Km/hr	580.562	0.895082	0.00796028

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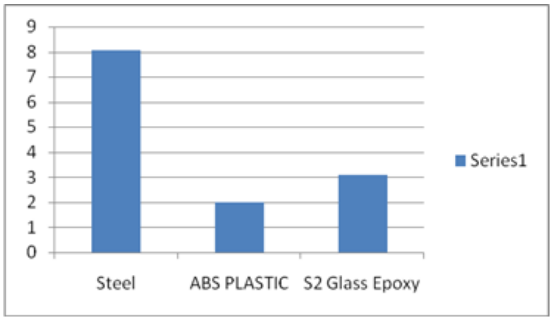
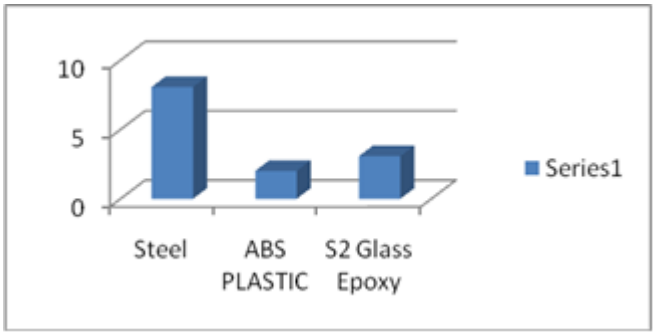
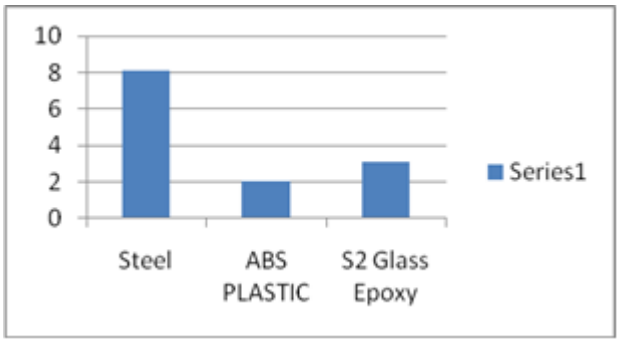


Graph.1.Stress Comparsion at speed



Graph.2.Displacement Comparsion at speed



Graph.3.Weight Comparsion

CONCLUSION

The Following conculsions can be drawn from the present work: Modeling of a car bumper is done using 3D modeling software Pro/Engineer. Impact analysis is done on the car bumper for different speeds of 40Km/hr, 60Km/hr. The analysis is also carried on the car bumper for different materials ABS Plastic and S2 Glass Epoxy. At Present the material used for car bumper is steel. Steel is replacing with ABS Plastic and S2 Glass Epoxy.

The density of ABS Plastic and S2 Glass is less than that of steel; thereby the overall weight of car bumper is reduced. By observing the Impact Analysis results like Stress, Displacement and strain , the stress values are less for ABS Plastic and S2 Glass than steel. By comparing the results of ABS Plastic and S2 Glass, the stress values are less for ABS Plastic than S2 Glass. ABS Plastic is better for utilization comparing S2 Glass Epoxy.

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