Impact Analysis of Car Front Bumper to Enhance Crashworthiness

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Abstract- *Bumper is the important part of an automobile vehicle. It used for safety of various front parts of vehicle as well as protection of occupants also from collision of vehicle. We know that the death in accident is very common not only in India but in the world. So the safety of occupants and passengers are primary criteria at the time of vehicle design and bumper play a vital role in safety of occupants. In this research we try to improve the impact strength of an existing car bumper by material optimization in economic way. We also emphasis on the light in weight of bumper to reduce the gross weight of vehicle which is very essential to increase fuel efficiency of vehicle.*

Creo used for modelling the existing bumper and ansys 16.0 used for meshing and calculation of stress & deformation at FMVS (federal motor vehicle safety standards) velocity13.34m/sec (48kmph) and at IIHS (Insurance Institute of Highway Safety) velocity17.78m/sec (64kmph) with existing material GFRP and suggest the best material for replace the existing material to improve the overall performance of vehicle on the difference criteria.

Keywords- *Bumper, Impact strength, Ansys*

I INTRODUCTION

Every day Car accidents are happening. Most troublesome situations are occurred to the drivers that they can avoid such. The statistics shows that ten thousand dead and hundreds of thousands to million wounded each year. Hence, improvement in the safety of automobiles is prerequisite to decrease the numbers of accidents. Automotive bumper system is one of the key systems in passenger cars. Bumper systems are designed to prevent or reduce physical damage to the front or rear ends of passenger motor vehicles in collision condition. It protects the hood, trunk, grill, fuel, exhaust and cooling system as well as safety related equipment such as parking lights, headlamps and taillights, etc. A good design of car bumper must provide safety for passengers and should have low weight. Different countries have different performance standards for bumpers. The function of automotive bumpers has changed considerably over the past 70 years. The later performance is achieved by a combination of careful design, material selection to obtain a particular balance of stiffness, strength and energy absorption. Stiffness and Energy absorption are essential criterion. Stiffness is important because vehicle design consideration limits the packaging space for the bumper design to deform under load and Energy absorption is important because bumper must limit the amount of the impact force transmitted to the surrounding rails and vehicle frame. Automotive bumper plays a very important role in absorbing impact energy (original purpose of safety) and styling stand point/aesthetic purpose. Now a day, automotive industry concentrates on optimization of weight and safety.

A Standards for bumper

In most jurisdictions, bumpers are legally required be legally specified as well, to ensure that when vehicles of different heights are in an accident, the smaller vehicle will not slide under the larger vehicle.

India

I. India is the 10th largest producer of automobiles in the world. The country's attention to vehicle safety requirements has progressed significantly since the year 2000. More than 35 million vehicles are registered in India. In 1989, the Central Motor Vehicle Rules (CMVR) became effective and the rules are greatly enforced today. Under Rule 126 of the CMVR, manufacturers of motor vehicles must allow a separate agency to test prototypes of new vehicle designs for safety requirements. It is necessary for all vehicles in India to have basic safety features, such as seat belts, rear-view mirrors and laminated safety glass for windshields. Also, all vehicles in use must pass a pollution test every six months.

B Types of bumpers

- Plastic bumper
- Boby kit bumper
- Carbon fiber bumper
- Steel 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. 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.

Boby 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, 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.

C Materials used in bumper

At one time, most car bumpers were made of steel. Then, most were made of chrome-plated material. Today, car bumpers can be made from anything from chrome-plated material to a variety of different rubber materials or plastics. This makes detailing car bumpers somewhat more complicated, as bumpers made from different materials require very different detailing treatments. For the purposes of this article, we will assume that your car bumper is chrome-plated. Detailing a chrome plated bumper requires a bit of patience and a light sanding touch, but it is certainly something that even the most casual car owner can accomplish in a day or less. The primary Enemy of chrome-plated bumpers is oxidation (rust). The longer you allow rust spots to remain on your bumper, the more difficult the detailing process is going to be. Bumpers on most new cars are color-coordinated plastic "wrappers," molded sleekly around the front and back ends of the vehicles. They may please the eye, but whether these bumpers protect the vehicle they surround from damage in low-speed impacts is another matter.

II Litrerature Review

[1] M. Anil Kumar1, N. Phani Raja Rao2 This research was to analyze the structural and material employed for car bumper in one of the car, material, structures, shapes and impact conditions are studied for analysis of the bumper beam in order to improve the crashworthiness during collision. An automobile's bumper is the front-most or rear-most part, 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. [2] Alok Kumar Khore1, Tapan Jain2 and Kartikeya Tripathi3The paper focuses on simulation and analysis of a Rear Under Run Protection (RUPD) system under crash scenario. The basic objective is to improve the safety of the car and the occupants by designing the RUPD and car bumper. The choice of material and the structural design are the two major factors for impact energy absorption during a crash. It is important to know the material and mechanical properties and failure mechanism during the impact. This study concentrates on component functions, geometry, behavior of material and other parameters that influence the compatibility of the car bumper and rear under run protection device. The analysis was carrying out using Finite Elements software (LS-Dyna), Meshing tools by Altair. Hyper mesh and Modeling on Pro-E. This analysis is a partial work of a major project. [3] Bibin S V1, Janaki Manogar 2In this paper investigates the improvement of GFRP car bumper's impact strength by the introduction of non-isotropic laminate composite methodology. The comparative analysis was also done in this paper between GFRP and Glass Fiber with Aluminum lamina by Ansys Workbench 13.0 [4] A. calienciugi1 Gh.N. Radu2 The present papers analyze the impact behavior of a composite car bumper made from new materials. The study is performed using Solidworks software for the design of the new car bumper made from new composite materials and the stress concentration distribution is evaluated by use of finite element analyze with Abaqus software for the impact cases.[5] P. Sampath Rao1 S.Saikumar2 The objectives of this study were to increase the physical understanding of the different phenomena taking place during the offset impact of an automotive bumper beam-longitudinal system as well as to validate a modeling procedure for the system's crash performance. In presented work the attempt has been made with Simulation of forming process for generating the FE-model of the bumper beam with required curvature. Finally the design and analysis bumper beam subjected to offset impact loading with different materials using FE-code ANSYS-LS DYNA and suggested the best material.

III. 3D MODELING OF BUMPER

Solid modeling in general is useful because the program is often able to calculate the dimensions of the it are creating. We prepared the 3D model of maruti swift desire existing bumper with dimensions in a CAD software CREO for simulation purpose.

Figure 1 Modeling of Bumper

IV ANALYSIS ON CAR BUMPER BY FEA

Stress Analysis

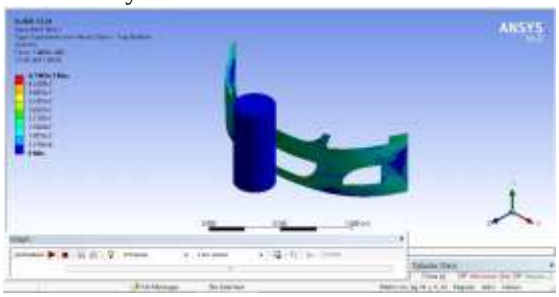

Figure 2 ABS Plastic Bumper at 13.34 m/sec

Stress Analysis

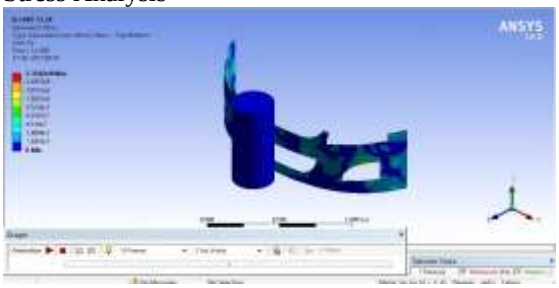

Figure 3 CFRP Bumper at 13.34 m/sec

Stress Analysis

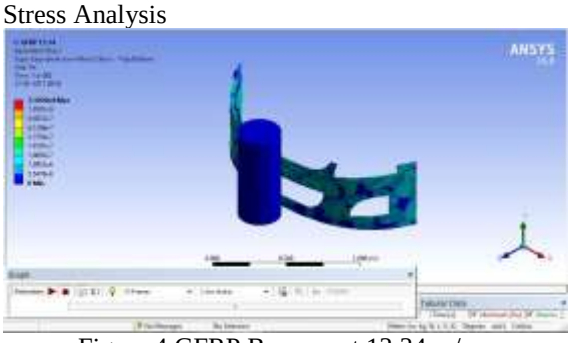

Figure 4 GFRP Bumper at 13.34 m/sec

Deformation

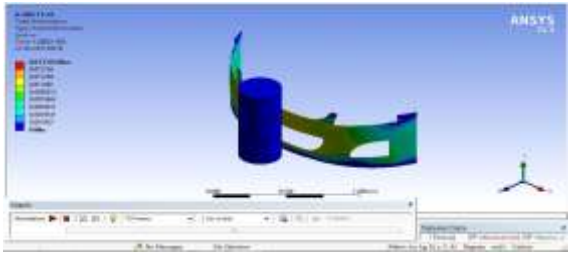

Figure 5 ABS Plastic Bumper at 13.34 m/sec

Deformation

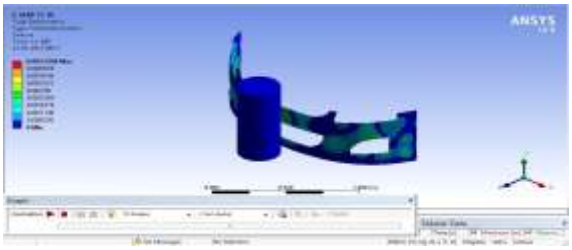

Figure 6 CFRP Bumper at 13.34 m/sec

Deformation

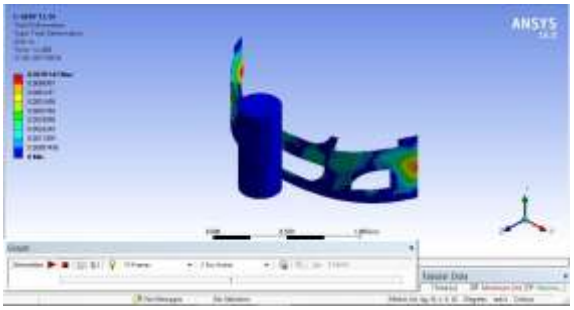

Figure 7 GFRP Bumper at 13.34 m/sec

Stress Analysis

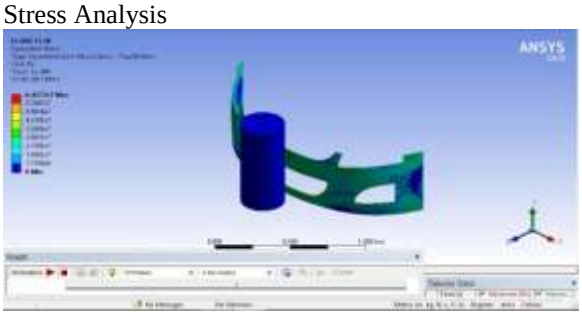

Figure 8 ABS Plastic Bumper at 17.78 m/sec

StressAnalysis

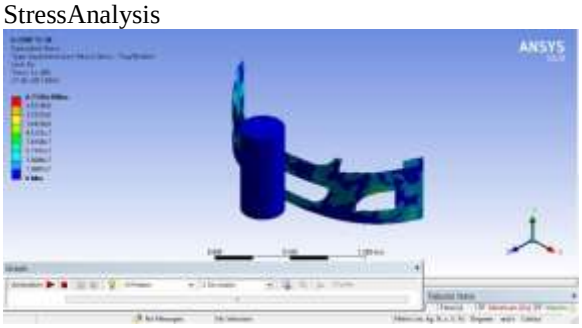

Figure 9 CFRP Bumper at 13.34 m/sec

Stress Analysis

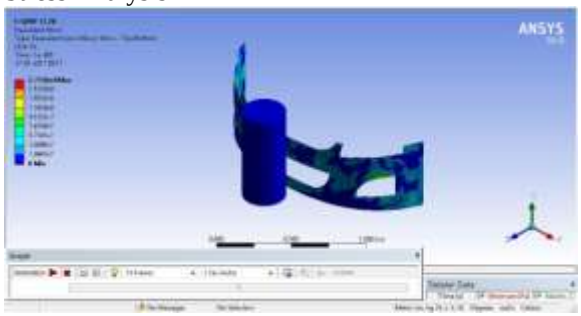

Figure 10 GFRP Bumper at 17.78 m/sec

Deformation

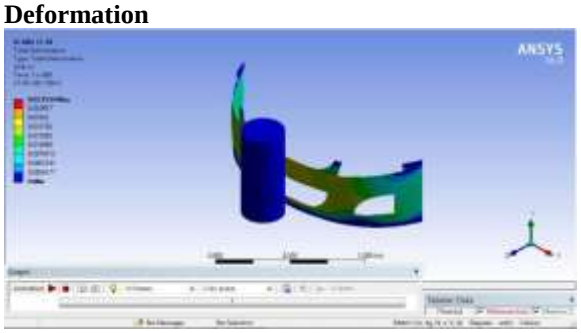

Figure 11 ABS Plastic Bumper at 17.78 m/sec

Deformation

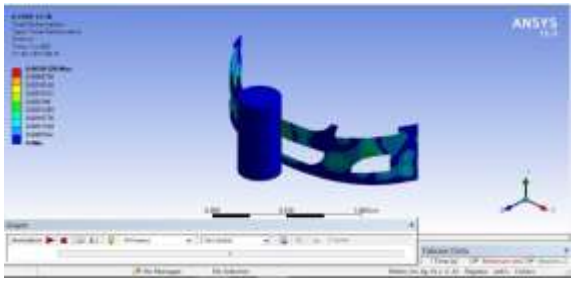

Figure 12 CFRP Bumper at 17.78 m/sec

Deformation

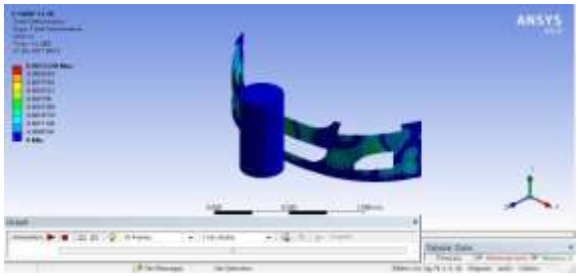

Figure 13 GFRP Bumper at 17.78 m/sec

V RESULTS

The following result obtains from the impact analysis of maruti swift desire car existing bumper whenever we use existing material with some other composite material.

Results and Validation Comparisons

Velocity m/sec	Material	Impact Stress (von misses stress) Mpa	Deformation in meter
13.34	ABS Plastic	47.48	0.01771
	CFRP Material	335.42	0.00386
	GFRP Material	219.29	0.00787
17.78	ABS Plastic	64.17	0.02355
	CFRP Material	471.4	0.00503
	GFRP Material	271.42	0.0053

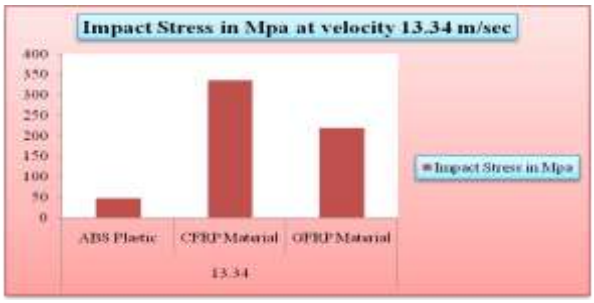

Figure 14 comparison of impact stress

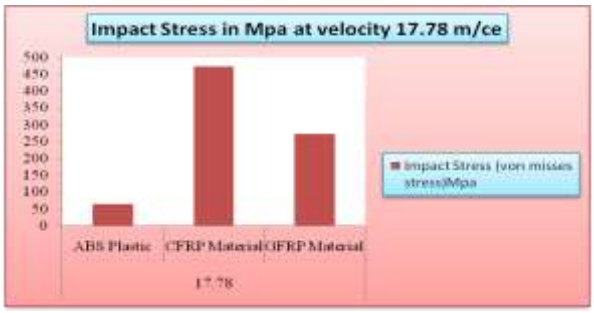

Figure 15 comparison of impact stress

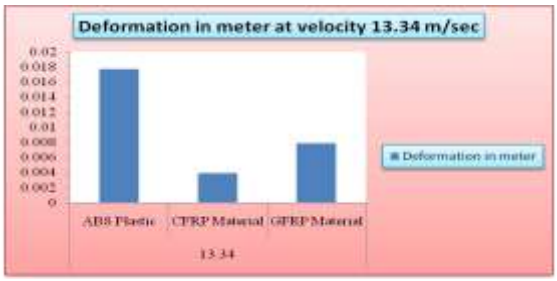

Figure 16 Comparison of Deformation

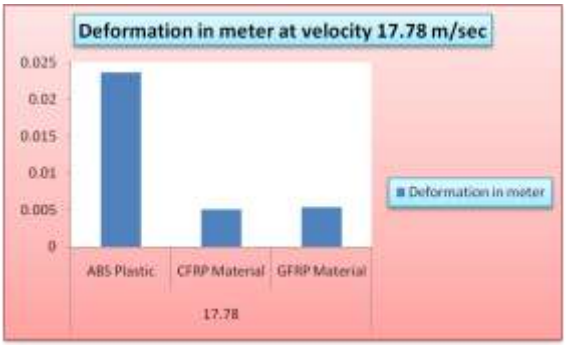

Figure 17 Comparison of Deformation

VI CONCLUSION

At the end of the research study on the basis of obtained results we can conclude that ABS Plastic Material showing least Impact stress and Maximum Deformation at the time of impact analysis compare to all other composite material which means ABS material bumper absorb more energy at the time of impact of vehicle. It is most desirable for bumper material Hence ABS Material is best material for swift desire car bumper and could be replaceable to existing bumper material GFRP.

VII CKNOWLEDGEMENT

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We Owe a debt of Gratitude to Mr. Sudhir Agrawal for the vision and foresight which inspired us to conceive this project.

VIII REFRENCES

1. M. Anil Kumar and N. Phani Raja Rao 'Design and Analysis of Car Bumper By Varying Materials and Speeds' International Journal on Recent Technologies in Mechanical and Electrical Engineering (IJRMEE) ISSN: 2349-7947 Volume: 2 Issue: 3 056 – 061

2. Alok Kumar Khore, Tapan Jain and Kartikeya Tripathi 'Impct Crashworthiness of Rear Under Run Protection Device in Heavy Vehicle Using Finite Analysis, Int. J. Mech. Eng. & Rob. Res. 2014 ISSN 2278 – 0149 www.ijmerr.com Vol. 3, No. 1, January 2014

3. Bibin S V, Janaki Manogar 'Comparative Analysis of Glass Fiber and Fiber Metal Laminates for Car Bumper' ISSN (Online) : 2319 – 8753 ISSN (Print) : 2347 - 6710 Volume 4, Special Issue 3, March 2015

4. A. calienciugi1 Gh.N. Radu 'Design and FEA Crash Simulation for a Composite Car bumper' Bulletin of the Transilvania University of Brasov Series I: Engineering Sciences • Vol. 5 (54) No. 1 - 2012

5.] P. Sampath Rao1 S.Saikumar Design Analysis of Bumper Beam Subjected to Offset Impact Loading for Automotive Applications' IJMET ISSN 0976 – 6340 (Print) ISSN 0976 – 6359 (Online) Volume 6, Issue 5, May (2015), pp. 64-71