International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
ISSN: 2457-0362

ANALYSIS OF FRONT BUMPER OF A CAR

A. Harish[1], V. Anurag[2] ,Sanjay Gouda[3], T.Venkata Sai Harsha Vardhan[4], Syed Abubakr Siddique[5]

[1]Assistant Professor, Department of Mechanical Engineering, CMR College of Engineering & Technology, Hyderabad.

[2,3,4,5] Student, Department of Mechanical Engineering, CMR College of Engineering & Technology, Hyderabad.

Abstract

Automotive design with economy, safety and aesthetics have been a great challenge to design engineers. Augmenting to these factors today environment impact is an upcoming research area. The safety of the passengers during vehicle crashes can be ensured to a certain limit by using good bumpers. At the same time these automotive parts should not be massive in terms of weight contributing to the increase in total the weight of the vehicle. The main purpose of bumper is to absorb shock in case of a collision. Several materials have been used to develop these shock-absorbing capabilities, such as steel, aluminum, glass mat thermoplastics and sheet molding compound. The purpose of this project is to design a bumper which is to improve crashworthiness of the bumper beam. Crashworthiness is the ability of the bumper beam to prevent occupant injuries in the event of an accident and this is achieved by minimizing the impact force during the collision. In this work, a bumper used for low passenger vehicle, Ford Festiva car is modelled by using the software CATIA V5R20. Then this model is imported into FEM impact as well as static analysis. The materials used for these analyses are Steel, Carbon/epoxy, Eglass/epoxy shows the lowest deformation and maximum von mises stress value.

1. INTRODUCTION

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 demandfacing 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. The front and rear of the vehicle should be protected in such a manner that low speed collisions will only damage the vehicle slightly, or not at all. For this purpose front and rear bumpers were invented. The uses of bumpers has evolved from being a mechanism placed on the front and rear of the car to protect the body and safety features of a motor vehicle from damage due to a low speed collision to a decorative ornament designed more for the aesthetics of the motor vehicle rather than the actual functionality. The study carried out by Federal Motor Vehicle Safety Standards and Regulations (FMVSS) highlights how the present day bumpers on motor vehicles are connected to the fenders rather than the frame of the motor vehicle where it would be of more use and steady during a low speed collision. The study also shows how some automobile manufacturers have tried to produce shock absorbent bumpers using shock absorbent resilient materials.

Problem statement

Consumers have to pay high price for damaged parts that need to be replaced due to low speed collision. Luxury cars, for instance are expensive not only to purchase but also to repair. Modern front-end styling results in bumper designs that can either slide under the bumpers or vehicles they strike or that simply do not have enough room to absorb the energy of a low-speed crash. The bars underneath bumper covers often are not up to absorbing the energy. The bars may not be big enough to provide much protection from damage or they may be too flimsy to absorb much energy. In this case a good bumper is required to minimize the damage by showing less deformation at the same should absorb maximum energy during collision. The weight of the bumper also adds to the total weight of the car. So, a bumper should also be less in weight without decreasing its efficiency.

Objective

The main objective of the project is to determine a light weight bumper to absorb the impact energy during a low-speed

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
ISSN: 2457-0362

collision. Low speed collision is defined as within the range of 2.5 km/h to 4 km/h. In order to achieve the main objective, the analysis of stress distribution on the bumper due to the collision, would be set as the secondary objective. The change in internal energy of the bumper is also analyzed to determine the energy absorption of the bumper during impact. Therefore, a standard steel bumper with specified dimensions and Carbon/epoxy, Eglass/epoxy bumpers are modelled and analyzed in Ansys AUTODYN. The results are compared with the results of standard steel bumper.

2. GEOMETRIC MODELLING

Modelling Of Pneumatic Bumper:

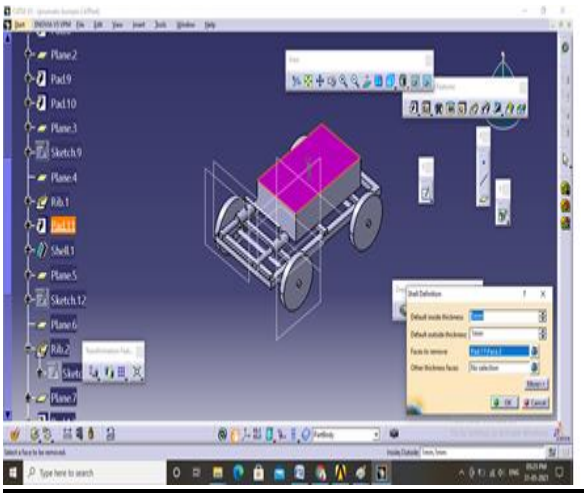

Fig. 1 Geometric modelling of Bumper hitting wall

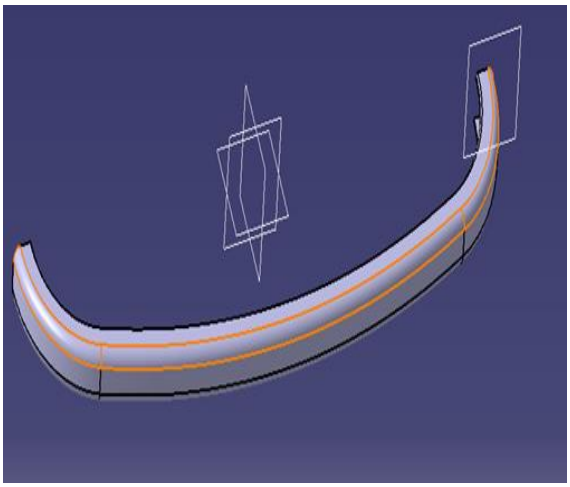

Fig 2 Completed bumper model with smooth edges

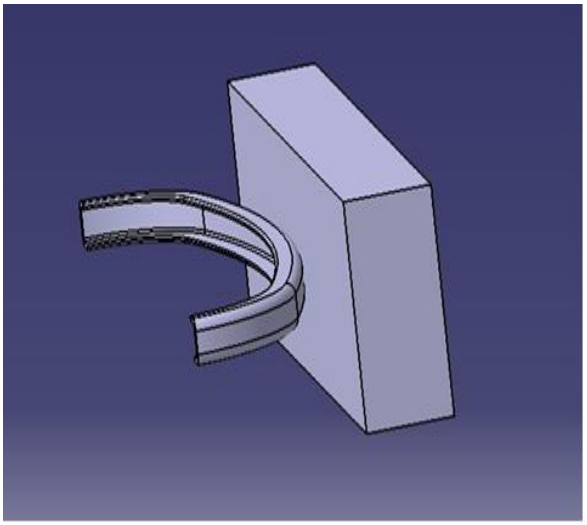

Fig 3 Bumper beam and flat barrier

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
ISSN: 2457-0362

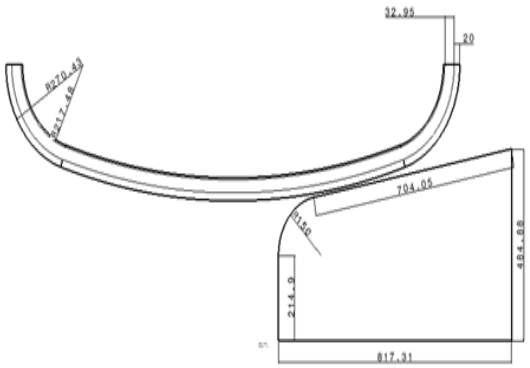

Fig 4 Sketch of bumper and impact barrier

Then a extrude tool is used to develop a solid model as shown in the following figure.

Mechanical properties of materials

Mechanical properties for the bumper materials are given below in the table

Material	Density kg/m^3	Poisson ratio	Young's modulus Mpa	Ultimate strength Gpa
Steel	7850	0.3	20000	460
Carbon/epoxy	1420	0.41	61340	805
Eglass/epoxy	2000	0.4	45000	415

Table 1 Properties of the bumper material

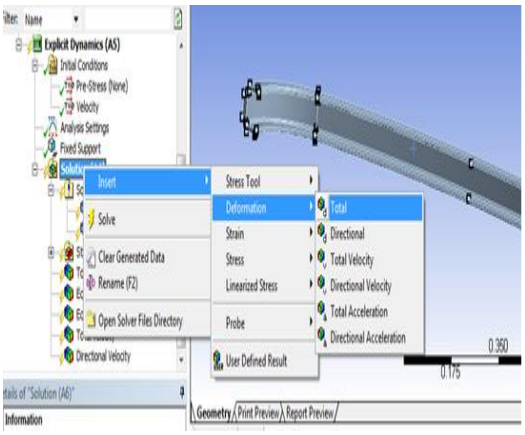

Fig 5 Assigning deformation

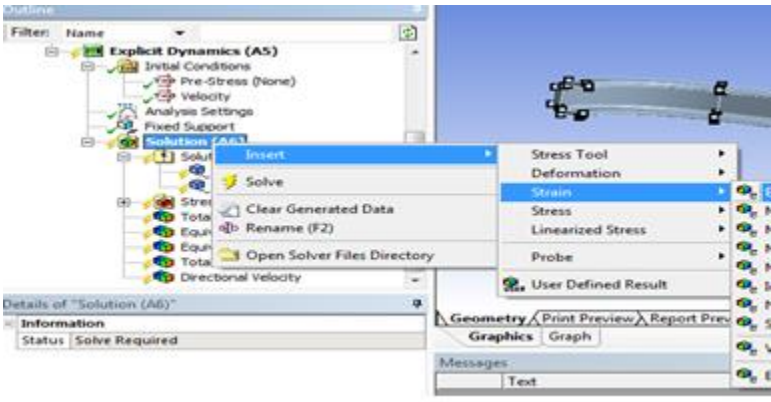

Fig 6 Giving equivalent strain

After all the output parameters are assigned, the problem is then solved. Ansys uses autodyn solver for solving the model.

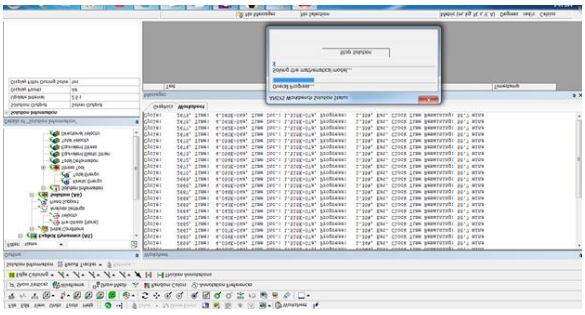

Fig 7 Solution status

3. RESULTS AND DISCUSSIONS

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
ISSN: 2457-0362

Table 2 Comparison of material stress and Deformation

Material	Stress (Pa)	Deformation (m)
Steel	175200000	0.019093
Carbon/epoxy	175210000	0.019531
Eglass/epoxy	169990000	0.028315

Table 3 Comparison of materials at 5m/s

Material	Stress (Pa)	Deformation (m)
Steel	501170000	0.0666
Carbon/epoxy	636580000	0.0700
Eglass/epoxy	357040000	0.0951

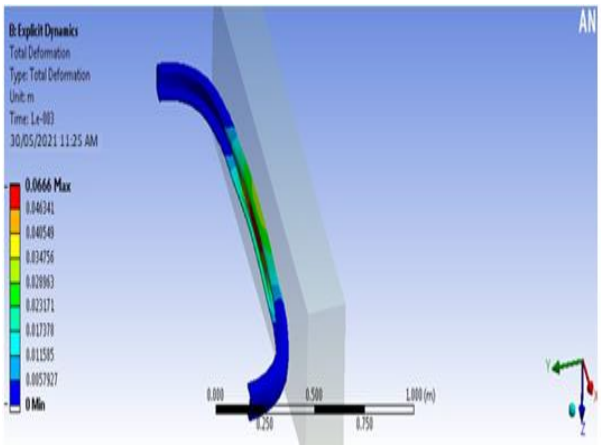

Fig 8 Deformation of steel at 5m/s

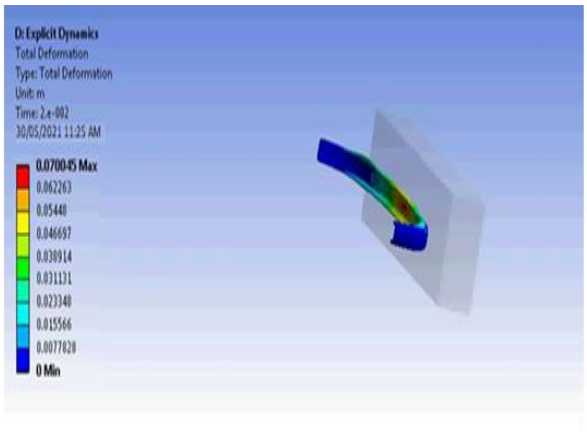

Fig 9 Deformation of Carbon /Eglass at 5m/s

4. CONCLUSIONS

Determining the best bumper is a typical task. A good bumper should have the following characteristicsA bumper should be able to absorb the energy during impact by allowing itself to deform.A good bumper should deform elastically during collision and should regain its original shape after the impact. Practically this is possible only at low speeds.The deformation should be limited to certain amount. If a bumper is allowed to take maximum deformation, it damages the parts of the automobile.The above charcateristics were all shown by all the three bumpers at 2m/s velocity. But the carbon epoxy bumper has shown less plastic deformation and more elastic deformation. Moreover the carbon epoxy bumper is having less weight making it the best

material for bumper.At increased speeds has shown less deformation than the other two bumper. Though the eglass/epoxy bumper has absorbed more energy it has shown maximum deformation which more than the clearance between the bumper and engine parts.

5. REFERENCES:

[1] Davoodi M M, Sapuan S M, Aidy A, et al. Development process of new bumper beam for passenger car : A review [J]. Materials & Design, 2012, 40 : 304-313.

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

[3] S. L. Stucki and W. T. Hollowell, "Determination of frontal offset test conditions
based on crash data," NHSTA R&D, 1998

[4] C. H. Lee, and C. K. Lee, "Low Speed Impact Analysis on Aluminum Bumper," Proceedings PAM Users Conference, Korea HAMPAM, 1996.

[5] K. S. Cheon, T. S. Lim, and T. S. Lee, "Impact energy absorption of glass fibre hybrid composites," Composite Structures, vol.46(3), pp. 267–278, 1999

[6] W. Abramowicz, "Thin-walled structures as impact energy absorbers," Thin-Walled Structures, vol. 41, pp. 91-107, 2003.

[7] Bryan C. Baker, Joseph M. Nolan, Brian O'Neill and Alexander P. Genetos , "Crash compatibility between cars and light trucks: Benefits of lowering front-end energy-absorbing structure in SUVs and pickups", Science Direct paper, 2007, pp.116-125.

[8] Brian O'Neill and Alexander P. Genetos , "Crash compatibility between cars and light trucks: Benefits of lowering front-end energy-absorbing structure in SUVs and pickups", Science Direct paper, 2007, pp.116-125.

[9] Park Dong-Kyou, Jang Chang-Doo. A study on the development of equivalent beam analysis model on pedestrian protection bumper impact [J].Journal of Mechanical Science and Technology, 2011, 25(9) : 2401-2411.

[10]http://www.nhtsa.gov/Vehicle+Safety/Test+Procedures - TP-581-01.pdf

[11] Nayak S.C., Misra B.B, "Extreme learning with chemical reaction optimization for stock volatility prediction", Financial Innovation, Vol. 6-Issue 1..

[12] Skandha S.S., Gupta S.K., Saba L., Koppula V.K., Johri A.M., Khanna N.N.,

Mavrogeni S., Laird J.R., Pareek G., Miner M., Sfikakis P.P., Protogerou A., Misra D.P., Agarwal V., Sharma A.M., Viswanathan V., Rathore V.S., Turk M., Kolluri R., Viskovic K., Cuadrado-Godia E., Kitas G.D., Nicolaides A., Suri J.S., "3-D optimized classification and characterization artificial intelligence paradigm for cardiovascular/stroke risk stratification using carotid ultrasound-based delineated plaque: Atheromaticâ„¢ 2.0", Computers in Biology and Medicine, 2020, Vol. 125-Issue.

[13] Gautam P., Ansari M.D., Sharma S.K., "Enhanced security for electronic health care information using obfuscation and RSA algorithm in cloud computing", International Journal of Information Security and Privacy, 2019, Vol. 13-Issue 1.

[14] Nayak S.C., Misra B.B., "Estimating stock closing indices using a GA-weighted condensed polynomial neural network", Financial Innovation, 2018, Vol. 4-Issue 1.

[15] Mahender K., Kumar T.A., Ramesh K.S., "Analysis of multipath channel fading techniques in wireless communication systems", AIP Conference Proceedings, 2018, Vol. 1952-Issue.