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ANALYSIS OF VARIOUS FRONTAL BEAM MATERIAL AND SECTION USED IN PASSENGER VEHICLE

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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 purpose of a crash analysis is to see how the car will behave in a frontal or sideways collision. Crashworthiness simulation is one typical area of application of Finite-Element Analysis (FEA). This is an area in which non-linear Finite Element simulations are particularly effective. The chassis frame forms the backbone of a heavy vehicle; its principle function is to safely carry the maximum load for all the designed operating conditions. The frame should support the chassis components and the body. The goal of this paper is to design a bumper with maximum safety by comparing various material and sections of bumper. This bumper either absorbs the impact energy with its deformation or transfers it perpendicular to the impact direction towards the chassis. To reach this aim, we studied analysis of bumper using steel and composite as material on various types of bumper sections .In addition, how the effect of bumper helps in distributing energy of impact towards various chassis parts of the car body is also studied for obtaining better results. For carrying out complete study CATIA R20 and ANSYS 14.5 is used for modelling and analysis respectively.

KEYWORD: Bumper, Bumper section, Chassis, Frontal Beam, Impact FEM

INTRODUCTION

Car accidents are happening every day. Most drivers are convinced that they can avoid such troublesome situations. Nevertheless, we must take into account the statistics – ten thousand dead and hundreds of thousands to million wounded each year. These numbers call for the necessity to improve the safety of automobiles during accidents. But also the development in technology demands engineering design field to be competitive and creative to meet the challenging competition. Nowadays, careful attention in meeting precision, eco friendly products and modularity in designing are gaining importance. The demand for new and customised personal vehicles is increasing at an exponential rate with the increase in buying power of customers. Transportation is identified as the major sector contributor to the

accidents and the CO2 emissions. The greatest challenges faced by the automotive industry have been to provide safer vehicles with high fuel efficiency at competitive cost.
In automobiles, a 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. 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. They protect 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. The presented work summarizes the present state of car passive safety testing according to European methodologies. The automobile bumper weight can be reduced by the use of composite and high- strength metallic sheet of a thin material. When the automobile is hit from the front or behind, the bumper beam collapses. The impact force is transmitted to the left and right front frames along the bumper beam and bumper stays. The impact energy produced during the crash is absorbed by plastic deformation on the bumper beam and bumper stays which are the important parts of the bumper.

PROBLEM DEFINITION

The impact condition, i.e., how test conditions other than the previously mentioned parameters can affect the impact behaviour. Steel and Composite structures with a specified thickness that did not fail during the test depicted clearly that they are not suitable as bumper beam structure due to increasing weight. In this study the steel and composite material are used and studied to find best impact behavior.For further more details we have also changed done the analysis on different types of sections of the same part To summarize, the objective of this research was to develop and propose a replaced composite bumper, which could satisfy following requirements:

1. Easy to manufacture by simplifying the shape.
2. Being economical by utilizing low-cost composite materials.
3. Achieving reduced weight compared to the metallic bumpers.

Achieving improved or similar impact behaviour compared to the current metallic structure.

EFFECTS OF FRONT CRASH ON CHASSIS AND VEHICLE BODY

3.1. TYPES OF CHASSIS

1. CONVENTIONAL CHASSIS OR FRAME-FULL CHASSIS

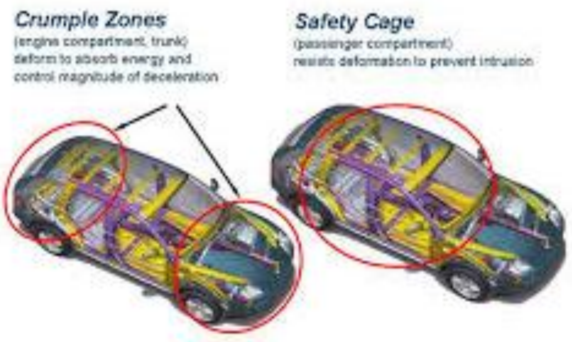
convetional chassis

In this type of chassis the body is made as a separate unit and then joined with ladder frame. It supports all the systems in a vehicle such as the Engine, Transmission system, Steering system, Suspension system.

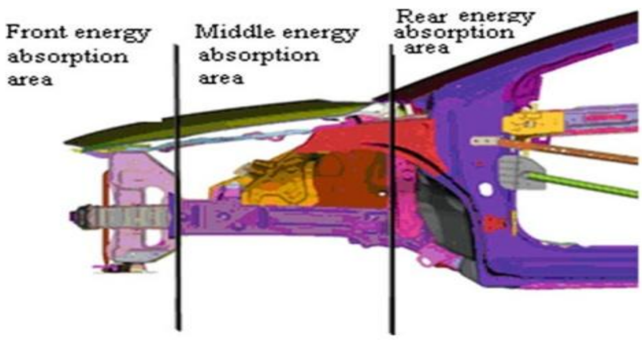
2. NON CONVENTIONAL OR FRAMELESS CHASSIS

In this type of chassis the ladder frame is absent and the body itself act as the frame. It supports all the systems in a vehicle such as the Engine, Transmission system, Steering system, Suspension system

3.2 CRUMPLE ZONE



Crumple zones are designed to absorb the energy from the impact during a traffic collision by controlled deformation. This energy is much greater than is commonly realized. A 2000 kg (4,408 lb) car travelling at 60.0 km/h (37.00 mph) (16.7 m/s), before crashing into a thick concrete wall, is subject to the same impact force as a front-down drop from a height of 14.20 m (47 ft) crashing on to a solid concrete surface. Increasing that speed by 50.0% to 90.0 km/h (56.0 mph) (25.0 m/s) compares to a fall from 32.0 m (105.0 ft) - an increase of 125.0%.This is because the stored kinetic energy (E) is given by E = (1/2) mass × speed squared. It increases by the square of the impact velocity. Crumple zones are located in front part of the vehicle, in order to absorb the impact of a head-on collision, though they may be found on other parts of the vehicle as well.



STANDARDS FOR BUMPER

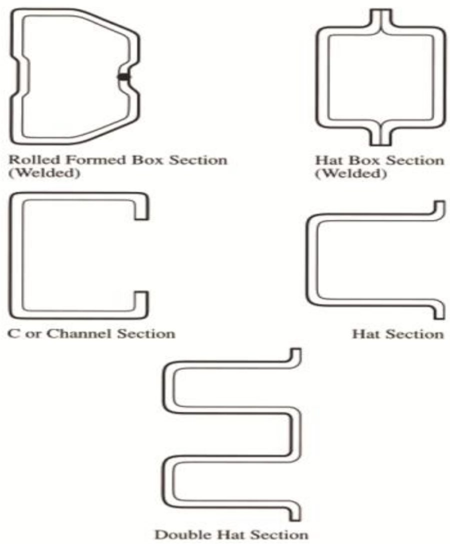
4.1. INTERNATIONAL STANDARDS

Under the International safety regulations originally developed as European standards and now adopted by most countries outside North America, a car's safety systems must still function normally after a straight-on pendulum or moving-barrier impact of 4 km/h (2.5 mph) to the front and the rear, and to the front and rear corners of 2.5 km/h (1.6 mph) at 45.5 cm (18 in) above the ground with the vehicle loaded or unloaded.

4.2. INDIA

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.

4.3. COMMON REINFORCING BUMPER BEAM CROSS SECTION



DATA COLLECTION

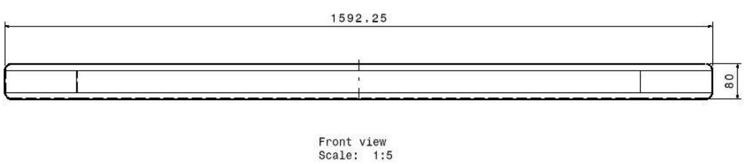
The properties of materials are as below

	Steel	Composite
Young's Modulus	2E^11	7.8E^10
Poisson's Ratio	0.3	0.27

The sections type of bumper used here are

- C section
- Box section
- Double hat section

Common dimension used for bumper modelling.



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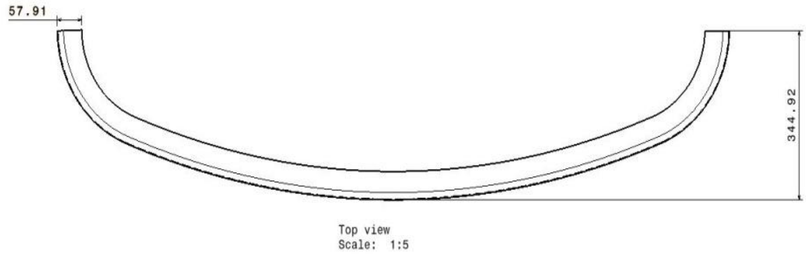
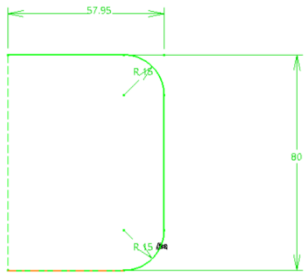
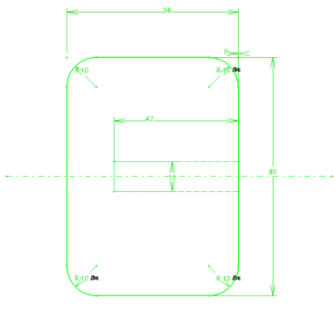
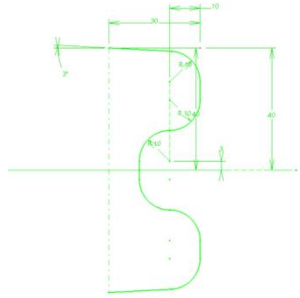


Sections Dimension

C section **Box Section** **Double hat Section**

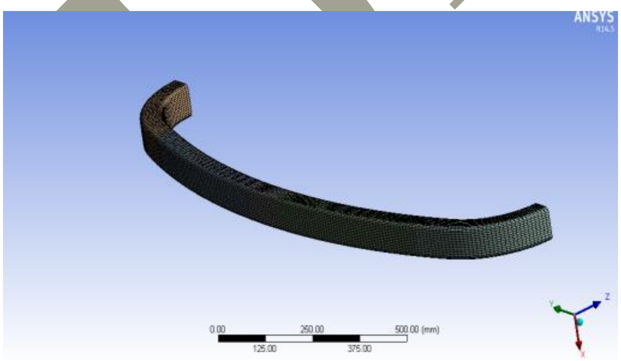


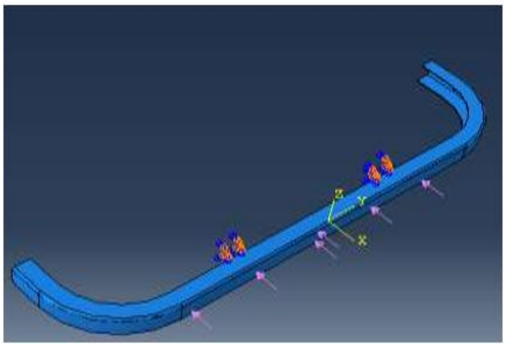




MESHING AND BOUNDARY CONDITIONS

The CATIA V5 CAD data of the bumper model was imported to Anys14.5. Then, meshing has created on a 3D model. Since the average thickness of the cover, conics and base plate is much smaller than the other dimensions of the part, the best element for meshing was the shell element Type of element (10-node modified quadratic tetrahedron). The meshing of the entire geometry results in 39632 nodes and 5421 elements. Meshing is only needed to the bumper There is no external force on the elements and no friction was assumed between the impactor and the bumper surfaces and the car was taken to be laying on a flat and frictionless surface and all other conditions.





FEA ANALYSIS ON BUMPER

This analysis was done by using ANSYS Workbench 14.5.After doing the finite element analysis like static, modal and the analysis under static loading by varying materials and varying sections without changing geometry, required results are obtained.

	Steel	Composite
C section	369.168	351.41
Box Section	374Mpa	380.23 Mpa
Double hat section	377 Mpa	372.9 Mpa

	Steel	Composite
C section	1.2	2.1
Box Section	1.143mm	2.9 mm
Double hat section	2.5 mm	6.4 mm

RESULT

A Car bumper is successfully modelled in modelling software CATIA V5 R20. And this model is analysed on finite element analysis on impact using ANSYS 14.5 successfully. Among the two materials (steel and composite) used for the static analysis, following results are obtained

- Composite possess highest von mises stress value.
- Composite possess lowest deformation, which suits the best among the two.
- Double hat section has the best result for deformation and stresses than other sections.
- Combination of Composite material and double hat section gives more assurance of safety in the complete study.

REFERENCES

1) [1] V. Kleisnera,∗, R. Zem ˇ c´ıka: *Appliedand ComputationalMechanics3 (2009)287–296-, 306 14 Plzeˇn, Czech Republic Received 30 August 2008; received in revised form 3November 2009*

2) G.A.Umadevi ; N.Ramesh: *International Journal of Research (IJR) e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 3, March 2015 Available at http://internationaljournalofresearch.org*

3) Pradeep Kumar Uddandapu: *International Journal of Modern Engineering Research (IJMER) www.ijmer.com, Vol.3, Issue.1, Jan-Feb. 2013 pp-391-395,ISSN: 2249-6645*

4) A.R. Mortazavi Moghaddam, M. T. Ahmadian: *World Academy of Science, Engineering and Technology International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering Vol:5, No:4, 2011*

5) Bhavesh A. Bohra, Prof. D. B. Pawar: *International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 3, Issue 12, December 2014 ISSN 2319 – 4847*