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Low Velocity Impact Analysis on Bumper Reinforcement Sections

Rizul Kumar[1], Pranav Jain[2] and Hemant Chouhan[3*]

[1,2]B.Tech Mechanical and Automation Engineering Amity School of Engineering and Technology
[3]Amity School of Engineering and Technology
E-mail: [1]rizulthkr@gmail.com, [2]pranavjain28@gmail.com, [3]hchouhan@amity.edu

Abstract—*Bumper beams are integral part in passenger cars for which careful design and manufacturing is needed in order to achieve good impact behavior. Since, suitable impact strength is the main expectation for the structure, [1] this research surveyed the parameters that directly affected impact characteristics and proposed easily achievable modifications resulting from impact modeling on different bumpers section. In the proposed work, an optimized bumper beam design is simulated for frontal impact and the results are compared with the standard sections available. The important parameters including shape, thickness and impact condition have been studied to improve the crash worthiness in high and low velocity impact. The simulation of the bumper beam is done according to the standard low speed impact conditions of RCAR (Research Council of Automotive Repairs) [2].The performance of bumper is investigated taking in consideration the energy absorption, impact force, stress and deformation within a calculated end time.*

Keywords: *Impact, Automobile, Safety, Bumper beam*

1. INTRODUCTION

Rapid development in the field automobiles has resulted in higher production rate of cars. Due to increase in the number of automobiles, roads have become more accident prone therefore demanding higher importance for the safety of passengers. There are a number of members in present date automobile, responsible for safety of passengers and bumper is one of the most important and first to cater the accidental load. Bumper beams are integral part in passenger cars for which careful design and manufacturing is needed in order to achieve good impact behavior [3]. The bumper beam is the main structure for absorbing impact energy [4].

The front bumper beam for four different sections [4] is prepared in CAD modeling software SolidWorks and impact modeling has been studied using commercial Finite Element Analysis package ANSYS to determine the deflection, stress distribution and energy absorption behavior. The modeling was done taking in consideration the standard bumper beam dimensions. The bumper beam is analyzed for E glass epoxy [5] under calculated impact load [6]

The simulation was carried out for low velocity [7] impact test. The average impact force was calculated taking in consideration the velocity of the car, distance travelled after impact and the mass of the automobile. This impact force was used to calculate the velocity of the impacting pole using work energy relation. The pole was simulated to impact the different bumper reinforcement sections. The dimensions of pole was uniform for all the section study and the simulation time was taken as.002174 sec calculated taking in consideration the pole velocity and the distance travelled after impact. In this paper a modified double hat section is proposed and it is compared with the standard sections in terms of energy absorption, stress and deformation.

2. FINITE ELEMENT ANALYSIS

2.1 Modeling

The CAD design of the bumper reinforcement was created using SolidWorks. The standard geometrical dimensions [8, 9] of the bumper system were prepared including mounting space for frame rail. Four different sections were designed along with the impacting pole and exported to ANSYS.

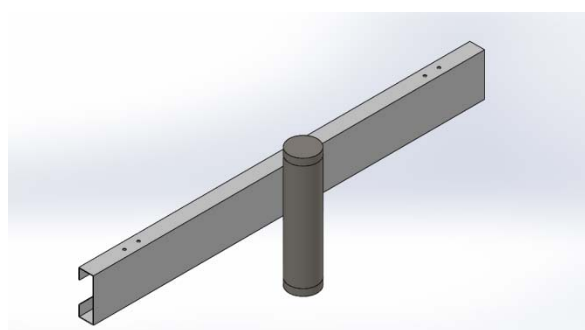

Fig. 1: CAD model of bumper section and impactor pole

2.2 Boundary condition

The boundary condition plays a crucial for obtaining real life impact behavior from the bumper system. Taking in consideration the system memory the boundary conditions have been optimized for result generation. The impactor is placed tangent to the bumper section for each study. The length of the pole is 400mm with a diameter of 100mm. The average impact force was used to calculate the velocity of the impactor which was allowed to penetrate 100mm after impact. The velocity was obtained to be 46m/sec for frontal crash. The displacement and velocity of the impactor was used to obtain the simulation end time of 2.174ms. The bumper system was fixed and the fixture was applied on frame rail faces. Properties of bumper material like tensile strength, elastic modulus, yield strength, density and passion ratio were added to ANSYS material library. The bumper beam was solved using explicit dynamics analysis system in ANSYS and the result were viewed in ANSYS prepost.

3. RESULT AND DISCUSSION

Explicit dynamics analysis system was used to determine stress, strain, internal energy and directional deformation for different bumper sections.

Impact force calculation were done taking in consideration the condition were a 3000lb car with a speed of 8km/hr retards after impact for 100mm. The obtained average impact force was used to calculate the velocity of impacting pole using work energy relation. The impact analysis between front bumper and pole involves evanescent and nonlinear conditions. The kinetic energy of the pole is absorbed by the bumper system as it undergoes deformation.

After the FEA analysis the obtained result for different sections are compared and inferred on basis of energy absorption and deformation behavior.

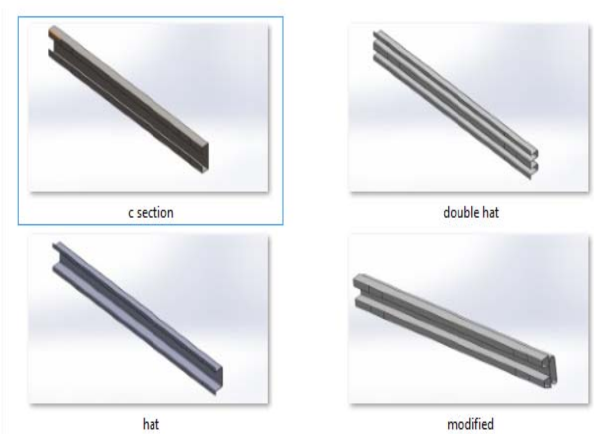

Fig. 2: Design of different sections

3.1 Directional deformation

In Fig. 3 the linear deformation for different bumper reinforcement sections are compared. The deformation is obtained due to the impact of pole with the bumper system. The hat and double hat sections show large deformation whereas the proposed new design shows the minimum directional deformation for the same average impact load.

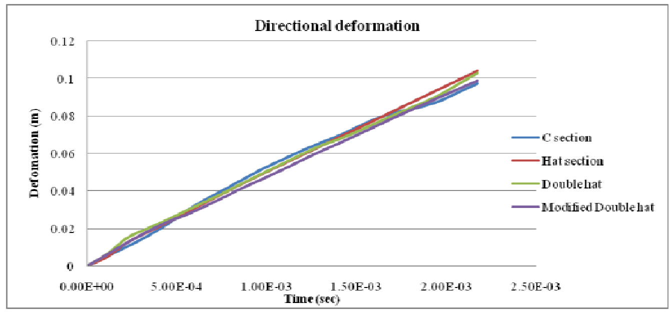

Fig. 3: Directional deformation of different sections

3.2 Stress and strain

The stress and strain values are obtained by simulating the impact condition for 2.174ms. The objective of the paper is to study the behaviour of the sections towards impact loading. As seen in Fig. 4 C, Hat and double hat sections exceed yield point at an earlier point of time which is not the same for the new proposed modified double hat section.

The stain values as seen in Fig. 5 is low for modified double hat and c section.

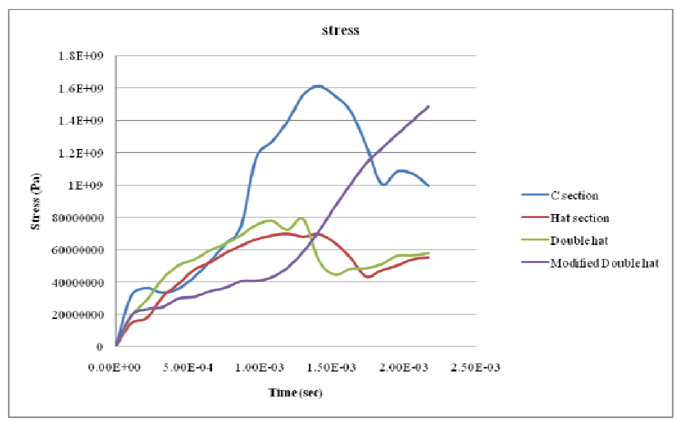

Fig. 4: Stress result vs time

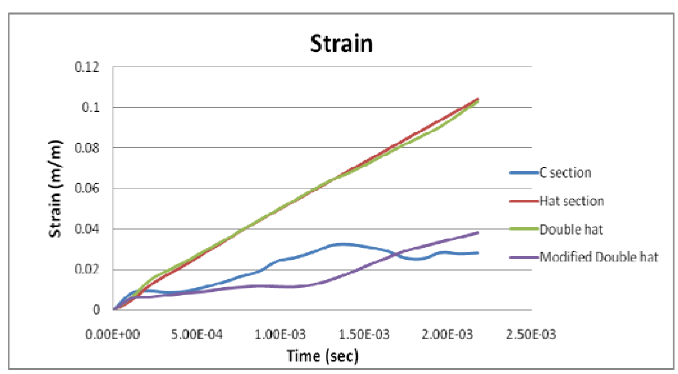

Fig. 5: Strain vs time

3.3 Energy absorbed

Energy absorbtion is a very important criteria in bumper system design. The bumper beam must be able to absorb the kinetic of the impact so that passanger as well as vital vehicular components are not affected.

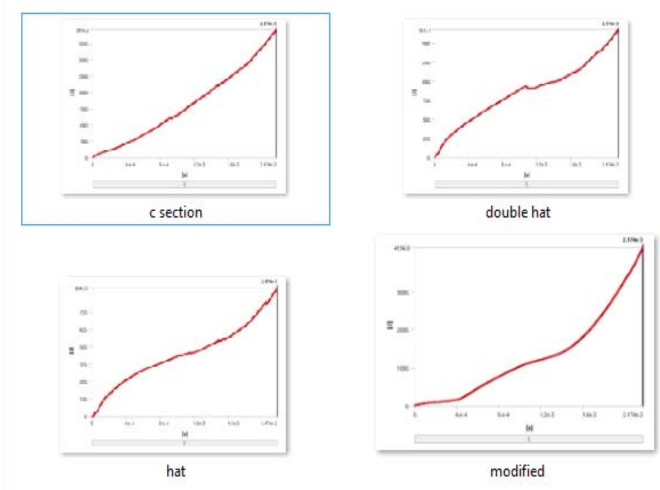

Fig. 6: Energy absorbed by different sections

In Fig. 6 a comparison of energy absorbtion is shown for the different sections on identical impact condations.

The pole is simulated to impact the sections with a calculated velocity and retards for 100mm towards the direction of impact producing an impact force equal to that of a 3000lb car impacting at a speed of 8km/hr. The simulation end time is the time required by the impactor at a speed of 46m/sec to penetrate inside 100mm which is the standard displacement used for calculating impact force.

The proposed new design that is the modified double hat section absorbs the maximum energy within the end time.

Table 1: Comparison of properties for different sections

Sections	Stress (pa)	Strain (m/m)	Deformation (m)	Energy Absorbed (J)
C section	9.9591 e+008	2.7987 e-002	9.735 e-002	3914.2
Hat section	5.536 e+008	1.4175 e-002	0.1039	924.13
Double hat	5.7737 e+008	1.4874 e-002	0.10287	1671.1
Modified double hat	1.4879 e+009	3.7947 e-002	9.8888 e-002	4154.9

4. CONCLUSION

The main purpose of a bumper beam is to absorb maximum energy and have minimum deformation for passenger and vehicular component safety. The stress, strain, deformation and energy absorption is studied and it inferred that the new optimized double hat section fulfills all the parameters and is better than the conventional sections

5. ACKNOWLEDGEMENT

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REFERENCES

[1] Cheon SS,Dai GL, Jeong KS. Composite side-door impact beam for passengercars. J Compos Struct 1997;38:229–39.

[2] RCAR Bumper Test Issue 2.0 September 2010

[3] Cheon SS, Choi JH, Lee DG. Development of the composite bumper beam forpassenger cars J Compos Struct 1995; 32:4919

[4] Cheon SS, Lim TS, Lee TS.Impact energy absorption of glass fiber hybrid composites. J Compos Struct 1999;46:267–78.

[5] Glass Mat Reinforced Thermoplastics Processing Guide lines for SYMALIT GMT Parts, Symalit AG, CH 5600 Lenzburg/Switzerland

[6] http://hyperphysics.phy-astr.gsu.edu/hbase/carcr.html

[7] Maeda R, Ueno S, Uda K, Matsuoka T. Strength test of aluminum alloy bumper for automobile. Furukawa Review1994 (13)

[8] Satyanarayana Kokkula, Bumper beam-longitudinal system subjected to offset impact loading, an experimental and numerical study PhD Thesis August 2005

[9] Applications – Car body – Crash Management Systems Version 2013 © European Aluminium Association (auto@eaa.be