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Design and Analysis of Automobile Front Bumper with Impact Attenuator

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ABSTRACT: Automobile's safety rating depends on the damping force and the kinetic energy absorbed during the impact thus protecting its occupants. Different tests are designed to imitate the types of car crashes that are responsible for the highest number of deaths and serious injuries on the road which include frontal, side barrier and side pole crash tests. With the industries focusing on reducing the cost of manufacturing and weight of the vehicle by decreasing the material usage, different structures are designed to absorb the kinetic energy from the crash during the vehicle's frontal crash and dissipate. This is done in a controlled and irreversible manner. Impact Attenuator is one among the designs which is used to withstand the impact energy in sports cars. In this project, the impact attenuator is analysed with different casing structures, which plays a crucial role in the rate of energy dissipation. The Attenuator is modelled with the thermoplastic polyurethane as the casing outer covering and its optimal design was found through explicit dynamic analysis. Through the analysis, it is found that the Canonical Frustrum attenuator with the Semi-Apical 17° has good compressibility factor and it is analysed with the car frame using ANSYS and the deformation of frame with the attenuator is studied with the frame impacting without attenuator.

KEYWORDS: Impact Attenuator, Semi-Apical Angle, Dynamic Analysis.

I. INTRODUCTION

In the recent day's road safety is emerging as a major social concern. Pedestrian crashes are a major safety concern worldwide. About one of every ten traffic-related fatalities in the country is a pedestrian. They were mainly exposed to risk when crossing and walking on the road in urban and rural areas. Lower limb injuries occur frequently in vehicle-to-pedestrian collisions and vehicle front-end shape has a significant influence on pedestrian lower limb injuries. Different approaches are employed to protect the pedestrians and the automobiles during case of impact. In this study impact attenuator is studied using the ANSYS with the Thermoplastic Polyurethane as the casing material and Aluminium for the Honey comb structure. Analysis is carried out using the explicit dynamics in ANSYS and the honey comb is modelled using the NX cad Software.

II. METHODOLOGY

The main objective of the study is to investigate the existing design of automotive/automobile impact attenuator designs. Explicit Dynamics analysis of the design is done with the different materials and with the results from the software the materials are chosen for the attenuator components.

- Material Study

The material study phase deals with the selection of the appropriate material for the impact attenuator design. Aluminum, copper and steel is selected for the for study of honey comb structure.

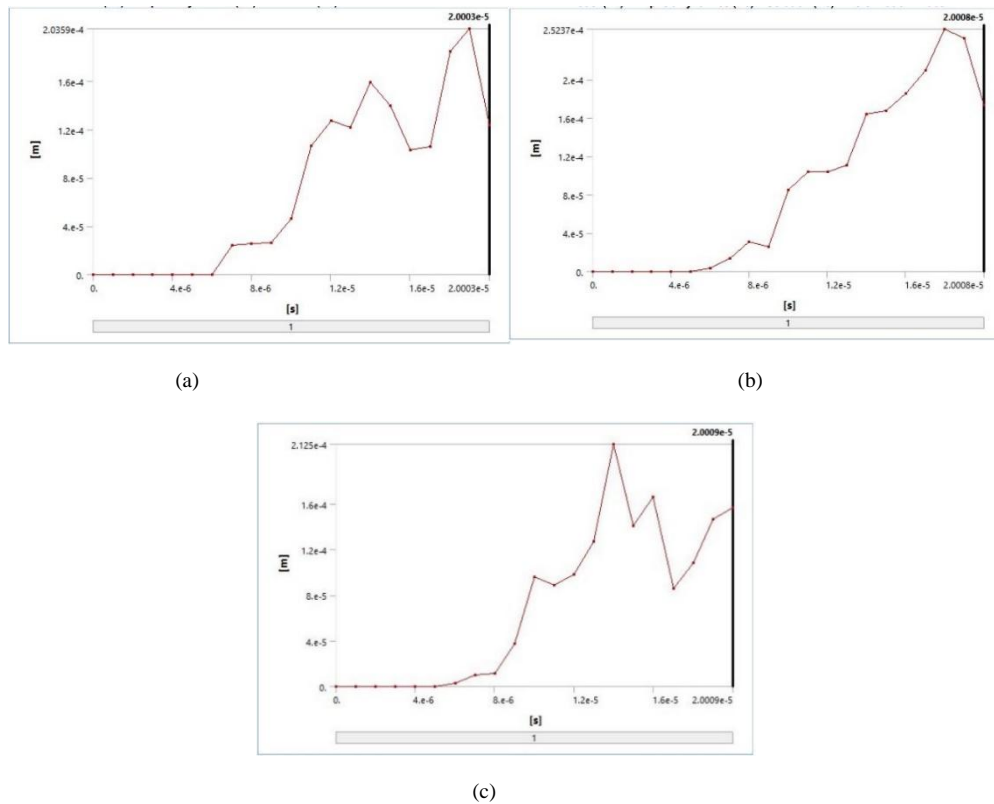


Fig.1.Material Study (a) Directional deformation of aluminium (b) Directional deformation of copper (c) Directional deformation of steel.

- Modelling

Honey comb is modelled using the Siemens NX CAD software.

IV. MODELLING AND ANALYSIS

Modelled attenuator dimension represents the dimension of an attenuator which is used in the sports cars.

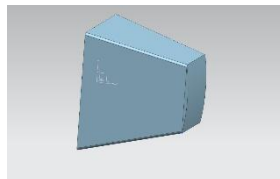


Fig. 2. 3D view of Modelled Propeller shaft

To validate the Constraints independency of the Casing material selected for the Attenuator a test is carried Using the Roller Sports Protective Equipment Testing method from the Korea Products Safety Association shock striker with 12 mm diameter was made to impact the plate of 5 mm thickness producing a force of 50 N in the Z Direction. The maximum impact force and stress were measured. To validate the Independence of the constraints the analysis is done is different constraints on the TPU plate for the same loading condition.

Compressive energy is calculated from the Force (N) and Displacement(m) by the following equation,

As per the Standard for the testing test is carried out using the following dimensions for pate and disc,

Load -50 N

Stricker Diameter - 12 mm

TPU Plate Thickness - 5 mm

TPU Plate Area - 360 mm²

Difference in Deformation value = 19.4514%



Energy of absorption(J) = [Pressure (Pa) × Unit Area(m²)] × Displacement (m)
 Energy of absorption(J) = Force (N) × Displacement (m)

where the force was calculated by multiplying pressure (Pa) and area of circle for vertical load (m²).

Total Energy Absorbed: Four Sides Constrained = 0.98 KJ
 Two Sides Constrained = 1.11 KJ

Difference between the energy absorbed in Two cases is 12.44% and hence the material is suitable for different constraints.

V. RESULTS AND DISCUSSION

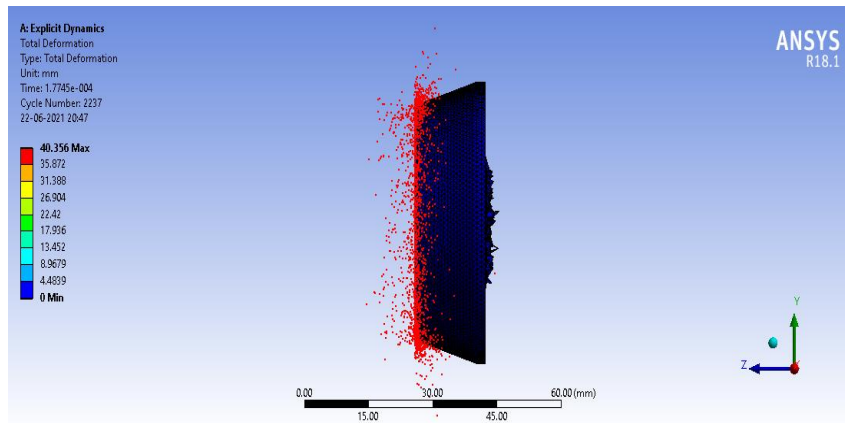


Fig.3. Attenuator deformation

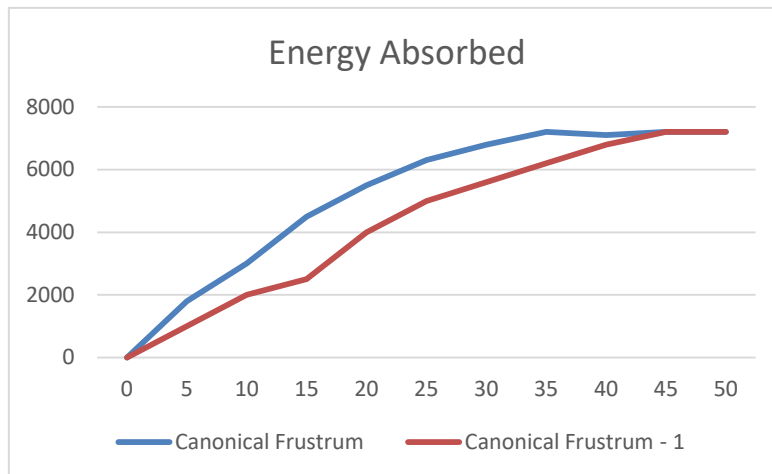


Fig.4.Examination between energy of the conventional and optimized shape Frustum tube

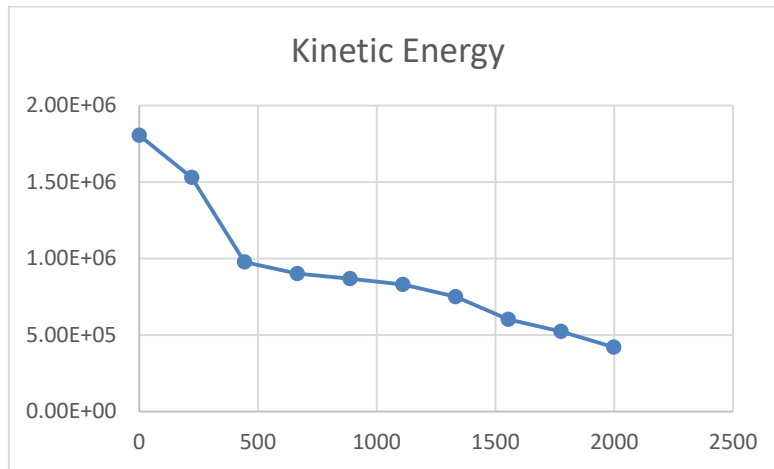


Fig.5. Kinetic energy plot

Kinetic energy plot of impactor is as shown in the graph. It can be observed that, Kinetic Energy of impactor used in model has lost more energy when compared. But as per total energy plot, reference model bumper absorbed very less energy which shows the effectiveness of the impact attenuator.

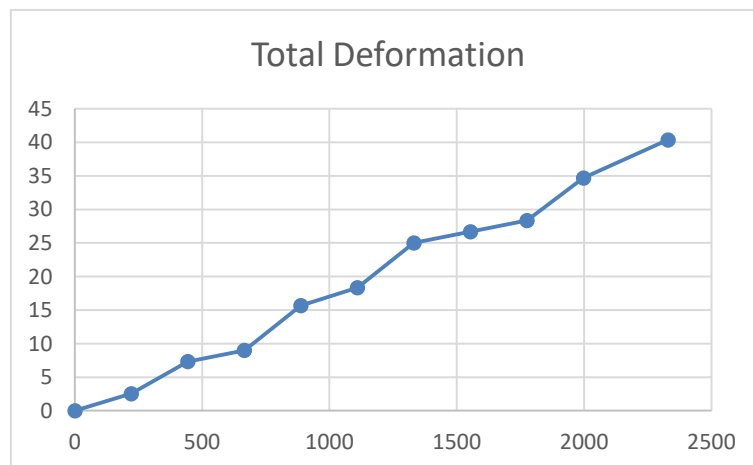


Fig.6. Total deformation plot

The total deformation graph shows the steady state of deformation of the Impact attenuator design and this shows the energy is dissipated to the structures of the attenuator and not on the frame of automobiles. Due to which the deformation of the frame is reduced and this saving the occupants of the vehicle.

VI. CONCLUSION

Analysis of the four initial design concepts showed that the conical tube frustum gave the highest SEA of 13665.15J/kg and in the parametric study Fmax were more influenced by wall thickness than semi-apical angle. It has been observed that choosing of appropriate wall thickness, Semi-apical Angle, protrusion and/or indentation geometry are crucial in the design of a tapered thin-walled tube impact attenuator.

Honeycomb simulation with the different configuration showed that, performance of HC structure is changing by changing the dimensions of the honeycomb structure. So, in order to improve its performance, lot more configurations were needed to be tested by changing its cell shape, cell size, wall thickness and overall structure thickness. The performance of bumper can also increased by choosing a different material that is being used of the honeycomb base structure. Currently, several advanced materials were available and can be used for the performance enhancement.

Trying upon the attenuator design for the automobiles the attenuator with aluminium honey comb structure is proven to be a good choice for energy dissipation in the study. The same design and analysis procedure can be carried out for increased loading conditions to mimic the real time situations. Use of energy absorbers between HC structures will also enhance the ability of absorbing energy and it also improves the pedestrian safety. And with the use of TPU (Thermo Plastic Polyurethane covered base panel will improve the energy absorbing capacity base structure and reduces the erosion caused by the action of friction. The energy absorbing capacity with the attenuator has increased by a value of 12% when compared with the values of the energy absorbed with the attenuator having a steel or other ferrous material as the casing structures. The results were calculated with the studied made by Phu Ma Quoc [26].

When compared the other energy absorbing structures like Crash Box which is used in the vehicles. When compared with the Crash box the weight of the impact attenuator is about 84%.

REFERENCES

- [1] Bilal Abdullah Baig, Hakimuddin. A. Hussain, Dr. A. M. Langde, Study of impact on car bumper-Literature review, International Journal for Innovative Research in Science & Technology, Vol-2, Issue 05, October 2015, 119-125pg.
- [2] A Chawla, S Mukherjee, Dileep Kumar, T. Nakatani and M. Ueno, prediction of crushing behaviour of honeycomb structures.
- [3] Kusekar sambhaji kashinath, chunge abhijit balasaheb, review of design & analysis of bumper beam in low speed frontal crashes, IRAJ International Conference Proceedings of ICRIEST-AICEEMCS, 29th December 2013, Pune India. ISBN: 978-93-82702-50-4.
- [4] Jeom Kee Paik, Anil K. Thayamballi, Gyu Sung Kim, The strength characteristics of aluminium honeycomb sandwich panels, Elsevier - Thin-Walled Structures 35 (1999) 205–231.
- [5] United states patent (US 3,744,835): Shock absorbing honeycomb bumper by Angelo F. Carbone, Brooklyn, N.Y.; Clinton F. Egerton, Stamford, Conn; Emmanuele Fellacaro, Com-mack, N.Y.
- [6] G. Sun, G. Li, S. Zhou, H. Li, S. Hou, Q. Li, “Crashworthiness design of vehicle by using multi-objective robust optimization”, China: Hunan University, Changsha, 410082. 2010.
- [7] G. Chiandussi, M. Avalle, “Maximisation of the crushing performance of a tubular device by shape optimisation”, Italy: Technical University of Turin, 2002.
- [8] L. Lanzi , L.M.L. Castelletti, M. Anghileri, “Multi-objective optimisation of composite absorber shape under crashworthiness requirements” Italy: Politecnico di Milano, 2004.
- [9] Y. Xiang, Q. Wang, Z. Fan, H. Fang, “Optimal crashworthiness design of a spot-welded thin-walled hat section”, USA: University of Iowa, 2006.
- [10] D. J. Eby, R. C. Averill, E. D. Goodman, R. S. Sidhu, “Shape Optimisation of Crashworthy Structures”, USA: Michigan State University, Proceeding of 7th International LS-DYNA Users Conference, 2007.
- [11] I. Babalola PO, Bolu CA, Inegbenebor AO, Odunfa KM (2014), Development of aluminum matrix composites- A review, Online International Journal of Engineering and Technology Research, 2014.2, 1-11, ISSN 2346452
- [12] Singla M, Dwivedi DD, Singh L, Chawla V (2009) Development of Aluminum based Silicon Carbide Particulate, Metal Matrix Composite. J Miner Mater Charact Eng 8(6):455–46
- [11] Deshpande, V. S., and N. A. Fleck, Isotropic Constitutive Model for Metallic Foams, Journal of the Mechanics and Physics of Solids, vol. 48, pp. 1253 – 1276, 2000.
- [12] E.A. Flores-Johnson, Q.M. Li and R.A.W. Mines, “ Degradation of Elastic Modulus of Progressively Crushable Foams in Uniaxial Compression”, Journal of Cellular Plastics, vol. 44, pp. 415–434, 2008, DOI: 10.1177/0021955X08095113
- [13] Skibo DM, Schuster DM, Jolla L (1988) Process for preparation of composite materials containing nonmetallic particles in a metallic matrix, and composite materials made by U.S patent.No. 4786467.
- [14] Hiroshi Enomoto, Yusuke Miyazaki, Hiroshi Mizuno, Eiji Hirano, Satoshi Kitayama, Koetsu Yamazaki and Naoki Uota. "Development of CFRP Monocoque Front Impact." ISCBC. Kanazawa University, KADO Corporation, 2007. Web. 2 Dec 2009.
- [15] Zhang, Q.; Zhang, J.; Wu, L. Impact and energy absorption of long fiber-reinforced thermoplastic based on two-phase modelling and experiments. Int. J. Impact Eng. 2018, 122, 374–383.
- [16] Balaji, G.; Annamalai, K. Crushing response of square aluminium column filled with carbon fibre tubes and aluminium honeycomb. Thin-Walled Struct. 2018, 132, 667–681.
- [17] Kranti S. Jadhav, S. R. Sandanshiv “Analysis of different Polygonal Cellular Structures under Impact Loading” International Journal of Science and Research, Volume 5 Issue 7, July 2016.



- [18] Komal A. Jangavali, D. P. Kamble “Finite Element Analysis and Experimental Evolution of Honeycomb Panel” International Journal of Science and Research, Volume 5 Issue 9, September 2016.
- [19] K.Kantha Rao, K. Jayathirtha Rao A.G.Sarwade, M.Sarath Chandra “Strength Analysis on Honeycomb Sandwich Panels of different Materials” International Journal of Engineering Research and Applications, Vol. 2, Issue 3, May-Jun 2012
- [20] Banoth Ganesh, B Vijay Kumar, D. Muppala “Design and Structural Analysis of Aircraft Floor Panel” International Journal of Advanced Engineering and Global Technology, Vol-03, Issue-12, December 2015.
- [21] Mohiyuddin.C.S, Jayalakshmi Raju, Manjunath Hedge “A Study On Behaviour of Sandwich Panels under Impact Loads” International Journal of Civil Engineering, April 2015.
- [22] Surya Satish Adapa, Janardhan Jaggavarapu and Vijaykumar Vedangi “Structural analysis of copper honeycomb structures” International journal of advances in engineering & technology, Vol. 8, Issue 6, pp. 950-957, Dec 2015.
- [23] Xiaojun Yang, Qingshan Lan and Yuning Zhong “Buckling analysis and experiment of fiber-paper honeycomb sandwich structure composites” Advanced materials research, August 2011.
- [24] Abderrahmane Bentouhami, Boualem Keskes “Experimental Analysis And Modeling of The Buckling of a Loaded Honeycomb Sandwich Composite” Original scientific article, March 2014
- [25] Murat Yavuz Solmaz, Kadir Turan “Experimental and Numerical Analysis of Critical Buckling Load of Honeycomb Sandwich Panels” Journal of Composite Materials, Vol. 44, No. 24/2010.
- [26] Phu Ma Quoc , David Krzikalla, Jakub Mesicek, Jana Petr , Jakub Smiraus, Ales Sliva and Zdenek Poruba “On Aluminum Honeycomb Impact Attenuator Designs for Formula Student Competitions”, “doi:10.3390/sym12101647”.



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