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An overview of design optimization of impact attenuator for racing car

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Abstract - *An impact attenuator is a device used to protect the vehicle from damage during a collision, thus preventing the risk of injury to the driver. Nowadays, with the increasing number of accidents that occur during the car races due to an increase of speed on the track, the pilot's safety has become a major area of research. The designer must be able to design and realize structures able to dissipate the greater amount of kinetic energy with progressive and controlled crushing, in order to avoid high deceleration peaks dangerous to humans. Given the complexity of the dynamic phenomenon and the use of new materials, time and cost of development tend to grow; these can be reduced to a large extent through the use of software dedicated to the finite element modelling of explicit type. The simulated results, however, cannot be used directly without any validation with the experimental results. The purpose of this work is to compare, numerically and experimentally, the dynamic response of a frontal impact attenuator made of steel alloys, fibre reinforced polymer, foam or combination of this material depending on availability properly glued and riveted in order to obtain a box type structure. The results of the finite element analysis, obtained through the use of the solver LS-DYNA, proved to be in good agreement with the experimental data, confirming the quality of the numerical simulation. Moreover, the designed impact attenuator met the requirements imposed by regulation, having load peaks and average deceleration during impact less than 40 g and 20 g, respectively.*

***Key Words*: LS-DYNA, CATIA, Design and Analysis, Impact Attenuator, Stresses.**

1.INTRODUCTION

Vehicle safety is one of the major research areas in automotive engineering. The car industry is developing safety systems and techniques to increase the safety of vehicle occupants. In order to ensure the driver's safety in case of high-speed crashes, special impact structures are designed to absorb the race car's kinetic energy and minimize the decelerations acting on the human body. An impact attenuator, which is also known as a crash cushion or crash attenuator, is a device that is used to reduce the damage done vehicle structure during collision of vehicle.
During car design, crash safety is one of the most important features. Crashworthiness is defined as the capability of a vehicle structure to provide adequate protection to its passengers from injuries in case of a collision. The safety requirements are done by the organizers of the specific competition to meet these regulations. Impact attenuator is nothing but an energy absorbing systems, that are fitted in front of the survival area occupied by the driver. This device is used to protect the vehicle from damage during a collision, thus preventing the risk of injury to the driver. The development of impact attenuator is costly and time consuming it depends on experimental procedure. For this purpose, we can use CAD software's like CATIA and CAE software's like LS-DYNA.

In this work the aim is to design and manufacture an impact attenuator using materials like steel alloy, fibre reinforced polymer, foam or combination of this material depending on availability and after testing it by experimentally and analytically, it can be validated.By considering all above facts, this paper tries to cover literature which deals with "Design optimization of impact attenuator for racing car ".

1. Numerical and experimental analysis of an impact attenuator in sandwich material for racing application

Simonetta Boria, [1] developed attenuator which is made from aluminium sandwich material with an honeycomb core separating two thin skins. Honeycomb has low density and high energy absorption capability; it is ideal for impact structures where weight saving is important. The shape chosen for the crash-box is a truncated pyramid. It subjected to axial dynamic loading. The explicit finite element code, implemented in LS-DYNA, was used to simulate the collapse mode of such structure and predict the energy-absorption capability. The numerical results were compared with the corresponding experimental test data. Thus they concluded that the designed impact attenuator is able to satisfy the specific homologation requirements of the FSAE, therefore can be used in front of racing car bulkhead during competition.

2. Design and physical testing of impact attenuator for formula sae race car

Nikhil S. Potabatti, [2] designed an impact attenuator with aluminium honeycomb and foam this foam is made from Rohacell 110IG foam it is found that Impact Attenuator made up of Rohacell 110ig foam satisfies all functional requirements and design rules set up by Formula

SAE.Advantages of the same Impact Attenuator are reduced weight, less volume occupied and flexibility in nose design of car. Impact Attenuator tested physically for its reliability on UNIVERSAL TESTING MACHINE, which have minimum load applying capacity 200KN. Impact attenuator could be tested under gradual load apply (quasi-static) condition. Based on the calculated results, it is found that Impact Attenuator made up of ROHACELL 110IG foam satisfies all functional requirements and design rules set up by Formula SAE. This attenuator provides better energy dissipation.

3. Design of the Impact Attenuator for a Formula Student Racing Car: Numerical Simulation of the Impact Crash Test

G. Belingardi,et al.[3] designed and numerically simulated a crash box in aluminium with a truncated pyramidal structure with rounded edges. The design also included strategically placed holes in the skins. Results have been analyzed by means of the software code Hyper View. Also, it is recommended in SAE rules that "average deceleration of the vehiclemust not exceed 20 g".Here average acceleration of the assembly that consists of car body and improved complete structure is about 14 g.

4. Cost Effective & Innovative Impact Attenuator for Formula SAE Car with Drop Test Analysis

Arpit Singhal, et al.[4] designed a shell of sheet metal and accommodates the bottles cans and make attenuator and test can carried out During the testing, it was realized that the sheet metal shell was creating problems in deformation. Thus, holes were made in the side faces of the shell of the final design.

5 . Study and Design of Impact Attenuator for Passenger Vehicle

Mayank Jain, et al. [6] developed an attenuator model For this first of all he shortlisted two materials for project, namely Galvanised Iron sheet (GI sheet) and Aluminium 2024 sheet efinal choice for the material was AL 2024 sheets being commercially available, light in weight and the sheets are easily weldable using tungsten inert gas welding. After developing the model it can validated with experimental data it concluded that from above analysis the average deceleration of maximum 20G is attained. So this Impact Attenuator if used in the reference vehicle will provide necessary safety to the passenger and the vehicle in case of any frontal collision. The final choice for the material was AL 2024 sheets being commercially available, light in weight and the sheets are easily weldable using tungsten inert gas welding.

8. CONCLUSIONS

From the literature survey it can be seen that the design and optimization of impact attenuator has been a good research topic for many researchers, due to its important role in design and stress analysis in impact attenuator. Also its material selection also its important parameter.

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