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Physical Testing of Impact Attenuator used for Racing Car

Shubham Jayant Patil[1], A. M. Naniwadekar[2]
[1, 2]*Dr J J Magdum College Of Engineering*

Abstract: ***Vehicle safety is one of the major research areas in automotive engineering. The car industry is developing new passive and active safety systems and techniques to increase the safety of vehicle occupants . Increased interest on vehicle safety has led to a comprehensive research of the crash response of vehicle from several points of view namely, simulation and experimental test . 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 limit 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 . Nowadays, with the increasing number of accidents that occur during the car races due to an increase of speed on the track, the driver 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 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.***

I. INTRODUCTION

Driver safety in case of accident is a main problem when developing a new vehicle design, and this is of particular importance when dealing with racing car. This is due to the higher velocity that generally characterizes the operation of a racing car with respect to a urban use vehicle. Higher velocity means higher (square power) kinetic energy to be dissipated in case of impact. 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. This paper is presenting the actual suitable materials for making impact attenuator used for racing car.

A. Description Of Problem

As per the rules, the impact attenuator must be:

1) Installed forword the bulkhead must be at least 200mm long with its length oriented along the fore and aft axis of the frame.
2) It must also be 100 mm high, 200 mm wide with a minimum distance of 200mm forward of the bulkhead. In any case, it should not penetrate the front bulkhead. The impact attenuator data requirement: Test data must show that their Impact Attenuator, when mounted a total vehicle mass of 300 kg run into a solid, non-yielding impact barrier with an impact velocity of 7 m/s, the attenuator must give an average deceleration of less than 20g.

B. Design Methodology

1) Material selection: Several factors considered in selecting a suitable material are weight, strength, cost, availability and manufacturability. Following materials are normally used to making the attenuator.

a) Aluminium alloy
b) Steel alloy
c) Galvanised Iron sheet (GI sheet)
d) Foam
e) Carbon composite
f) Kevlar etc.

The design of impact attenuators should be of lightweight materials, which may contribute to improving the acceleration performance and fuel economy of the vehicle. The structure of impact attenuator is of various types viz. tube and plate type, honeycomb structured, truncated trapezoidal shaped and sandwich structured so mostly aluminium alloy or steel alloy used for making an attenuator. .On a cursory look upon the attenuators made in the past the most obvious materials were Steel and its alloys, Aluminium and its alloys. On further, detailed study for the mechanical properties of materials we shortlisted a material which is steel alloy and combination of steel alloy with either CRP or foam depending upon availability of the material. Generally they choose because of its easy availability, strength and cost.

B)Design and manufacturing of impact attenuator - Overall dimensions of the attenuator taken were 200 x 200 x 100 mm3.This impact attenuator is manufactured using steel alloy.

Fig. Actual manufactured steel alloy

2) Testing: After fabrication of Impact Attenuator it can be tested physically by using Drop test. Impact attenuator could be tested under dynamic load apply condition. The mass 300 kg was dropped on the impact attenuator, which was kept on the ground from a known height 2.5m. The velocity obtained become 7m/s. The drop test was recorded with help of a high speed camera where they record time when deformation start and deformation stop.

II. OBSERVATION AND CALCULATIONS

During the test, an steel alloy was tested to see how it behaves and what actual result can be obtained. The calculations for average decelerations are shown below.

For steel alloy,
Deformation Start Time = 15.420s
Deformation End Time = 15.461s
Total Deformation Time, t = 0.041s
Average Deceleration, a = (v-u)/t
= (7-0)/0.041

= 170.73m/s2
= 17.40g

III. RESULTS

The behaviour of an Impact Attenuator for Formula SAE race car has been described with detailed material selection, design methodology and physical testing procedure. From the above data, it can be seen that the deceleration is ok in case of steel alloy when it is in proper manner.

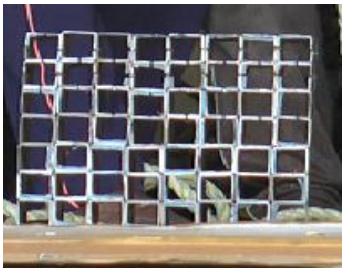

Fig . Attenuator before impact

Fig . Attenuator after impact

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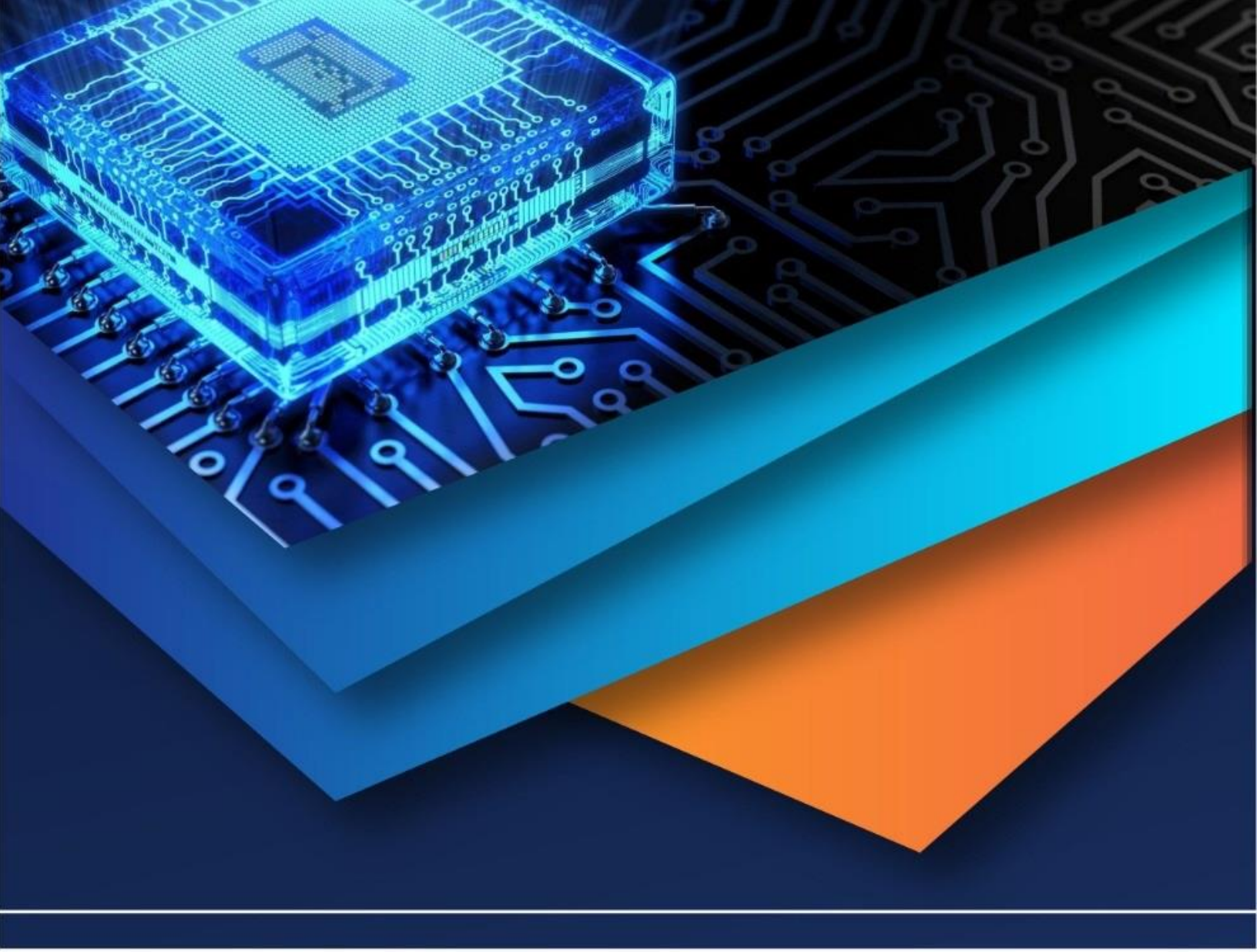

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