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A STUDY OF THE IMPACT ATTENUATOR

Mahir Hussain*

*Assistant Professor,
Department of Mechanical Engineering, Faculty of Engineering,
Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, INDIA
Email id: mahir.engineering@tmu.ac.in

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ABSTRACT

The impact attenuator provides a charge channel for transverse and vertical loads in the event of off-center and off-axis collisions. The impact attenuator is distinguished by the concentration of energy dissipation in a limited zone and the recognition of the system by a static body movement. The impact attenuator minimizes vehicle frame damage and protects the driver from personal injury during the collision, according to the study. The impact dimmer's crush can absorb kinetic energy and evenly transfer low load to the remainder of the system. To understand the behavior of vehicle impact crushing, this paper examines academics' work in the areas of design and impact mitigation analysis. The researchers' geometric structure and material choice for the impact attenuator are briefly described first, followed by the FEA analysis and experimental testing techniques. The experimental and simulation experiments will be split into three groups: test, simulated test, and comparison.

KEYWORDS: *FEA, Lightweight material, Impact Attenuator, Vehicle.*

1. INTRODUCTION

The impact attenuator is a crucial component of the vehicle and the most important equipment in a racing car since it acts as a barrier between the driver and the impacted region. The impact attenuator is intended to flex evenly to absorb the vehicle's kinetic energy while retaining a low degree of force. If the deformation caused by G's spikes is unequal, the driver may be harmed. Significant longitudinal tension and cracking are often used to absorb energy[1]. By constructing impact attenuators using lightweight materials, it is possible to improve vehicle acceleration and fuel economy.

An impact attenuator, also known as a crash cushion, crash attenuator, or cowboy cushion, is a device intended to reduce the damage to structures, vehicles, and motorists resulting from a motor vehicle collision. Impact attenuators are designed to absorb the colliding vehicle's kinetic energy. They may also be designed to redirect the vehicle away from the hazard or away from roadway machinery and workers. Impact attenuators are usually placed in front of fixed structures near highways, such as gore points, crash barrier introductions, or overpass supports. Temporary versions may be used for road construction projects. Impact attenuators are designed to absorb the colliding vehicle's kinetic energy to bring it to a stop safely. If no impact attenuator is present, a vehicle which strikes a rigid roadside object will suddenly stop.

A person inside will promptly collide with the interior of the vehicle, and that person's internal organs will collide with their chest wall, causing severe internal injuries and possibly death. By safely dissipating the vehicle's kinetic energy, impact attenuators help prevent such injuries.

Impact attenuators can be categorized by the method used to dissipate kinetic energy:

- Momentum transfer. Many early models used successive rows of sand- or water-filled barrels or modules. Momentum is transferred to the sand or water, reducing the speed of the impacting vehicle.[2]
- Material deformation. Many newer attenuators use crushable materials (like various kinds of foam) that create a crumple zone, absorbing energy.[2] Others flatten a corrugated steel guard rail section, or split a steel box beam.
- Friction. Some attenuators work by forcing a steel cable or strap through an angled slot or tube, converting kinetic energy into heat.

Titanium, wave burn, nomex, carbon fiber, Kevlar, or aluminum foil are popular impact attenuators because they provide the driver with the best possible protection [2].

Because it serves as a safety barrier between the driver and the hit surface, the impact attenuator is a critical component of the vehicle and the racing car's most essential structural The impact attenuator is intended to absorb kinetic energy from the vehicle in the form of even deformation while keeping the force level low . If the deformation is uneven, the driver may be injured as a result of G-force spikes. The energy is usually absorbed by the structure being crushed and crumbled extensively In the case of off-center and off-axis collisions, the impact attenuator offers a load route for transverse and vertical loads[3]. The impact attenuator's crashworthiness is evaluated in terms of total and specific absorbed energy. The rate of energy dissipation in an impact attenuator is focused over a small zone, while the structure's components undergo stiff body motion Figure 1 shows a schematic representation of an impact attenuator[4]. The impact attenuator is attached to the chassis' bulkhead. Lightweight materials should be used in the design of impact attenuators, which may help to improve the vehicle's acceleration performance and fuel efficiency. Aluminum, honeycomb, nomex, carbon composite, kevlar, aluminum foil, or a mix of these materials are often used as impact attenuators since they offer the best protection for the driver. Impact attenuators come in a variety of shapes and sizes, including tube and plate structures, honeycomb structures, truncated trapezoidal shapes, and sandwich structures.

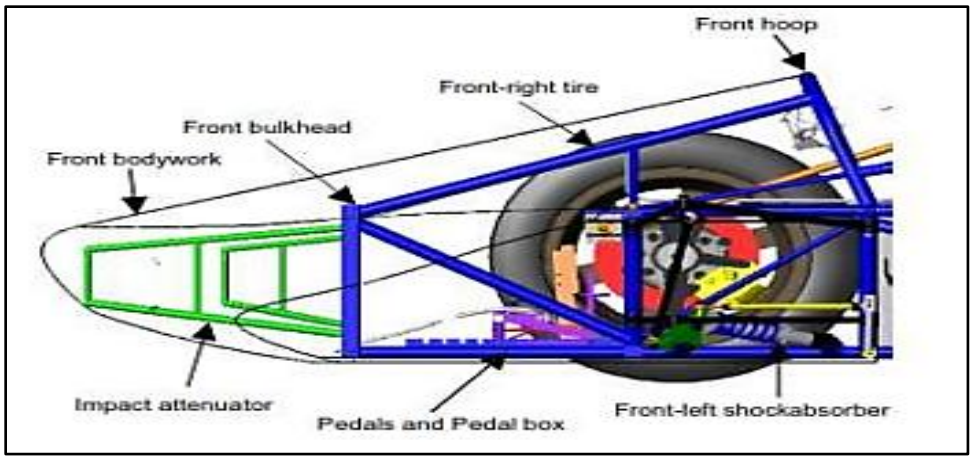

Figure 1: Schematic of Front Part of FSAE Vehicle.

A wreck, crash, cowboy, or cowboy cushion is an impact attenuator that reduces the damage caused by motor vehicle accidents to structures, vehicles, and drivers. Impact attenuators are often intended to keep the vehicle out of harm's way or to keep it away from road infrastructure and personnel. Fixed structures near highway roadways, such as gore points, accident barrier introduction, and overpass supports, are usually surrounded by impact attenuators. Attenuators for impact are designed to resist kinetic energy. Provisional models may be utilized in road construction projects. The purpose of an impact attenuator is to absorb the kinetic energy of colliding vehicles in order to safely halt them. If a vehicle collides with a solid object on the roadside and has no impact attenuator, it may come to a sudden halt. An internal human will collide with the vehicle's interior in a moment, and the person's inside organs will collide with their chest wall, causing severe internal damage and death. The impact attenuator helps to prevent such collisions by effectively dispersing the vehicle's kinetic energy [5].

Impact attenuators are defined by the mechanism employed to disperse kinetic energy:

- Change the motion. Many versions utilized a series of barrels or modules filled with sand or water in a row. The vehicle's impact speed is reduced when sand or water is displaced.
- Stuff that causes deformation Crushable materials (such as various types of foam) are used in many modern attenuators to create a crumpled area that absorbs energy. Others cut a beam in a steel box or flatten a railway corrugated steel guard.
- Rubbish. Any attenuator converts film energy into heat by pushing a steel cable or strapping into a tube or angle slot.

The impact attenuator is placed on the chassis' bulkhead.[6]. The use of lightweight materials in the car's design may assist to improve acceleration and fuel efficiency. Titanium, waveburn, nomex, carbon fiber, kevlar, or aluminum foil are popular impact attenuators since they provide the driver with the most protection. Impact attenuators come in a variety of shapes and sizes. Sandwich with an organized tube and plate form, as well as a truncated trapezoid shape and structure. It's all about speed in motorsports, but it comes at the expense of driver safety. This study focuses on the design, development, and testing of an impact attenuator for the vehicle's front end. There have been a few fatalities in Formula One. The FIA has also established certain

guidelines for all driver safety teams. Measures to protect the driver in the event of a rollover, side collision, or frontal effect have been implemented.

Technical advancements in the automotive sector have developed throughout this time period. One of them is the concept of fast vehicles. The greater the vehicle's speed, the safer the driver will be. In this instance, the student formula specifies that each team must utilize the impact attenuator for the driver's safety. Impact mitigation may be defined as artifacts that can withstand a collision and maintain the effect. Cabin that is stable. The technique of attenuating the impact, in addition to its capacity to use energy, also functions as an attenuator for the effects, as well as being quick to produce and acquire necessary materials. The effect attenuator is also affected by the form of a rectangular prism, a steel truncated pyramid, and cubes. A labyrinth consuming day and even a simple process based on the material selected by a truncated pyramid are examples of impact decreasing forms. If you click to distribute the load out from the front for the selected impact attenuator, a truncated pyramid will appear. For the crash scenario, a truncated pyramid was selected. An axial loading objective is one of them [7].

2. LITERATURE REVIEW

The impact attenuator is a crucial component of the vehicle and the most important equipment in a racing car since it acts as a barrier between the driver and the impacted region. The impact attenuator is intended to flex evenly to absorb the vehicle's kinetic energy while retaining a low degree of force. If the deformation caused by G's spikes is unequal, the driver may be harmed [8]. It's all about speed in motorsports, but it comes at the expense of driver safety. This study focuses on the design, development, and testing of an impact attenuator for the vehicle's front end. There have been several tragic incidents in Formula One [9].

The greater the vehicle's speed, the safer the driver will be. In this instance, the student formula specifies that each team must utilize the impact attenuator for the driver's safety. Impact mitigation may be defined as artifacts that can withstand a crash hit while maintaining the effect of a stable cab. In addition to the capacity to use power, the technique of attenuating the impact also serves as an attenuator for the effects, as well as being quick to produce and acquire necessary materials [10].

3. DISCUSSION

Vehicles weighing 2 250 pounds or more have been the subject of previous impact attenuation tests and assessments (1023 kg). Because of the recent increase in minicar sales, this class now accounts for a significant part of the vehicle population (1800 lb, 818 kg, and range). This raises concerns about additional automobile accidents. Minibuses' tiny size and weight decrease wheelbase lengths, track widths, and crush space, as well as mass inertia times, when compared to bigger vehicles. Variations have an effect on how the vehicle reacts in a collision. A total of 20 accident tests were conducted under the federal highway administration's (FHWA) contract titled "Experience Attenuators-A Current Engineering Assessment" to explain the behaviors of small automobiles in impact attenuation crashes.

- The project's main objectives were to investigate the complexity of small and full-size automobiles that are presently colliding with impact attenuators on our nation's highways.

- To investigate the effectiveness of inertial effect attenuators with different fill materials and technologies in order to identify issues related with frozen sand.

In the case of off-center and off-axis collisions, the impact attenuator offers a charge route for transverse and vertical stresses. The energy dissipation in a restricted zone distinguishes the impact attenuator, as does the identification of the system by a static body movement. It is feasible to enhance vehicle acceleration and fuel efficiency by utilizing lightweight materials to build impact attenuators. Impact attenuators made of titanium, wave burn, nomex, carbon fiber, Kevlar, or aluminum foil are popular because they provide the greatest protection to the driver. The impact attenuator is a key component of the vehicle and the racing car's most important structural component since it acts as a safety barrier between the driver and the crash surface. The purpose of the impact attenuator is to absorb kinetic energy from the vehicle in the form of even deformation while maintaining a low force level. G-force spikes may cause injury to the driver if the deformation is unequal. The energy is typically absorbed by the structure, which is heavily crushed and disintegrated. The impact attenuator provides a load path for transverse and vertical loads in off-center and off-axis impacts.

The bulkhead of the chassis houses the impact attenuator. Impact attenuators should be made of lightweight materials, which may assist enhance the vehicle's acceleration performance and fuel economy. Impact attenuators are often made of aluminum, honeycomb, nomex, carbon composite, kevlar, aluminum foil, or a combination of these materials since they provide the greatest protection for the driver. Tube and plate constructions, honeycomb structures, truncated trapezoidal forms, and sandwich structures are some of the many types of impact attenuators available.

4. CONCLUSION

The prior researches on impact decrease in recent years have been thoroughly reviewed in this thesis. The literature on effect attenuator science has been shown, and all important contributions have been made. The most recent literature evaluation came to the following conclusion: -

- The impact attenuator minimizes vehicle frame damage and protects the driver from personal injury during the collision, according to the study. The impact dimmer's crush can absorb kinetic energy and evenly transfer low load to the remainder of the system.
- The study shows that the majority of architectural research focuses on decreasing the impact attenuator's weight. The impact attenuator's weight has a significant effect on the overall vehicle weight allocation. Furthermore, the material used for the impact attenuator should have a high ability to absorb energy while remaining within a deformation tolerance range.
- Previous research on comparative analysis of impact attenuator experimental and simulation tests has shown that the same pattern crushes the impact attenuator. In research, simulation-based analysis is therefore simpler and more practical.

An impact attenuator's job is to absorb the kinetic energy of colliding cars and bring them to a safe stop. If a car collides with a solid item on the roadside and does not have an impact attenuator, the vehicle may come to a complete stop. In a split second, an inside human collides with the vehicle's interior, and the person's inner organs collide with their chest wall, resulting in

serious internal injury and death. By efficiently distributing the vehicle's kinetic energy, the impact attenuator aids in the prevention of such collisions.

REFERENCES:

1. M. M. Squires and L. F. W. Lesack, "Spatial and temporal patterns of light attenuation among lakes of the Mackenzie Delta," Freshw. Biol., 2003.

2. J. Fahland, C. Hoff, and J. Brelin-Fornari, "Evaluating Impact Attenuator Performance for a Formula SAE Vehicle," SAE Int. J. Passeng. Cars - Mech. Syst., 2011.

3. T. Sugimoto and T. Kawaguchi, "Development of a surface defect inspection system using radiant light from steel products in a hot rolling line," IEEE Trans. Instrum. Meas., 1998.

4. N. Takahashi et al., "Two year operation of the Precipitation Radar (PR) onboard TRMM satellite," in International Geoscience and Remote Sensing Symposium (IGARSS), 2000.

5. S. Boria, J. Obradovic, and G. Belingardi, "Experimental and numerical investigations of the impact behaviour of composite frontal crash structures," Compos. Part B Eng., 2015.

6. G. Belingardi and J. Obradović, "Design of the impact attenuator for a formula student racing car: Numerical simulation of the impact crash test," J. Serbian Soc. Comput. Mech., 2010.

7. J. Hinch, D. Sawyer, D. Stout, M. Hargrave, and R. Owings, "Impact attenuators: a current engineering evaluation," Transp. Res. Rec., vol. 1198, pp. 76–89, 1988.

8. N. Agrawal, J. Raj, and G. Saxena, "Design and Analysis of Impact Attenuator: A Review," Int. J. Mech. Eng., 2015.

9. N. S. Potabatti, "Design and Physical Testing of Impact Attenuator for Formula Sae Racecar," Int. J. Sci. Eng. Technol. Res., 2016.

10. F. Imanullah, Ubaidillah, A. S. Prasojo, and A. A. Wirawan, "Experiment evaluation of impact attenuator for a racing car under static load," in AIP Conference Proceedings, 2018.