OPEN ACCESS

Volume: 7

Issue: 4

Month: April

Year: 2020

P-ISSN: 2321-788X

E-ISSN: 2582-0397

Received: 24.12.2019

Accepted: 26.02.2020

Published: 01.04.2020

Citation:
Sabarinath, P. "Passive Safety System for Side Impact in Cars." *Shanlax International Journal of Arts, Science and Humanities*, vol. 7, no. 4, 2020, pp. 115–120.

DOI:
https://doi.org/10.34293/sijash.v7i4.1623

Passive Safety System for Side Impact in Cars

P.Sabarinath
Associate Professor, Department of Mechanical Engineering
K.L.N. College of Engineering, Pottapalayam, Sivagangai, Tamil Nadu, India

Abstract
The ultimate aim of this work is to provide the safest ride for the peoples. The following contribution is to protect the precious life of the driver and the co-passengers during the accidents by increasing the distance between the impact zone and the passengers, peculiarly during the crash on the sides. This can be achieved by incorporating a pneumatic cylinder under the seats, which is then actuated by the solenoid valve triggered by the deformation caused by the crashing vehicle. This makes the seats tilted at the time of the accident away from the near side of the door, which saves the life. The high-pressure energy in the container gives ultimate kinetic energy using high velocity gives a sudden actuation of seats in a fraction of seconds clearly say 0.3 seconds. We have re-designed the structure and mechanism of car seats to make it possible to save precious lives. Our design idea does not stop with single possible way of saving the life, it extends to lot of customization and adaptability based on the car structure and available space specific to various brands and models.
Keywords: Injuries, Safety Systems, Side Impacts, Smart Seat

Introduction

The term "Passive Safety" denotes the safety feature that comes into action during the accident to protect passengers. Side impact crashes account for a substantial proportion of injuries and harm to passenger car occupants. They account for around 25% of all injury crashes, and substantially, 40% of severe injury crashes (where the passenger is either hospitalized or killed).

Improvements in passenger vehicle crashworthiness have been an important factor in declining death rates, but protecting vehicle occupants in side impacts is especially challenging. Most passenger vehicles have substantial crumple zones in the front and rear, but the sides have relatively little space to absorb impact forces while limiting occupant compartment intrusion. Severe head and thoracic injuries are common and result from impacts with the intruding side structure or objects outside the vehicle.

The passive safety system is an innovative way, in which we have re-designed the structure and mechanism of car seats to make it possible to save precious lives by pushing the seats away from the door by tilting before the impact with the help of pneumatic systems incorporated under the seats. The Pneumatic system under the seats with in the confined Space to actuate the seats within the accident period say 0.3s to protect the Passengers from fatality.

The innovation we found does not stop with a single possible way of saving life. Instead, it extends to a lot of customization and adaptability based on the car structure and available space specific to various brands and models. The mechanism enables us to save the life of the passenger by increasing the distance between the impact vehicle and the victim.

Existing Safety Measures for Side Impacts

Increased side door strength, internal padding, and better seats can improve protection in side-impact crashes. Most new cars have side intrusion beams or other protection within the door structure. Some cars also have padding on the inside door panels.

Curtain Airbags: Airbags are one of the most important safety innovations of recent decades. They provide crucial cushioning for people during a crash. The devices are normally hidden from view but inflate instantly when a crash begins. Thanks to the advocacy of IIHS and others, frontal airbags have been required in all new passenger vehicles since the 1999 model year. Side airbags aren't specifically mandated, but nearly all manufacturers include them as standard equipment to meet federal side protection requirements.

Seat Belt: A seat belt is a vehicle safety device designed to secure the occupant of a vehicle against harmful movement that may result during a collision or a sudden stop. A seat belt functions to reduce the likelihood of death or serious injury in a traffic collision by reducing the force of secondary impacts with interior strike hazards, by keeping occupants positioned correctly for maximum effectiveness of the airbag and by preventing occupants being ejected from the vehicle in a crash or if the vehicle rolls over.

Side Impact Door Beams: Side-impact door beams are a safety feature of modern cars designed to protect the driver and passengers. When a crash occurs, door beams work by absorbing the energy created during the collision.

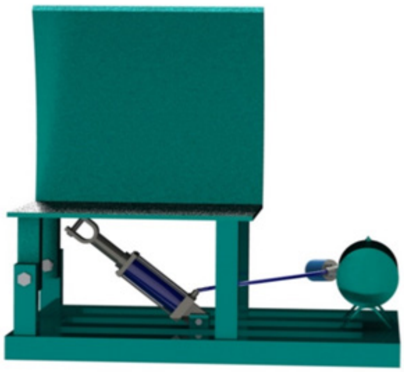
Smart Seat Mechanism

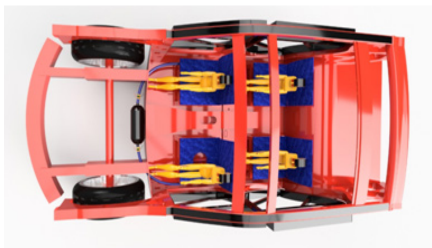
The main idea of our project is a pneumatic system that made possible the design, analysis, and fabrication of the Project. The reason for choosing the pneumatic is for its uncompromising speed of actuation. The under-seat installed the Pneumatic system actuates at the very moment of the accident and tilting the seats away from the door and avoid collision of the passenger with the vehicle.

The actuation is achieved by the closing the circuit to the solenoid valve which is attached to the foot peg of the car, the deformation of the bar in the foot peg closes the circuit and opens the solenoid valve which thrusts the air into the pneumatic cylinder at unimaginable velocity and pressure to the aim of protecting the precious life of the people who is going to experience the whooping 25g's of force from the demon crushing the doors at sides.

The high-pressure air from the reservoir rushes via connections of the pneumatic system tilt the seats because of the hinged support at the one end, thus increases the distance of life away from the crushing door and protect the most vulnerable parts of the body like pelvis, thorax, head, thanks to the automatic seat belt pre-tensioner which holds firmly the people in the seats.

3D Model of Smart Seat



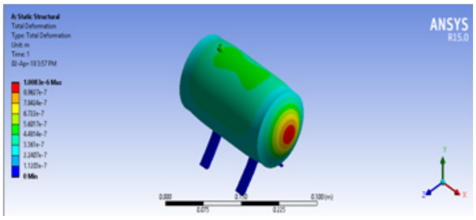


Analysis Report

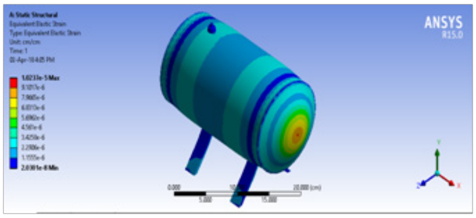
Analysis of Pressurized Container

The analysis of pressurized containers at various operating pressures and conditions to ensure the safety of the car, if implemented in the real world. The analysis is done in Ansys 15.0, provided that the pressure does not cause any adverse effect on the container; everything is in the normal condition. The real-world conditions like temperature from the Engine, Atmosphere, and higher pressure than the operating conditions are given to ensure at most level of safety to the people's life and practical implementation.

At 10 bar Pressure:

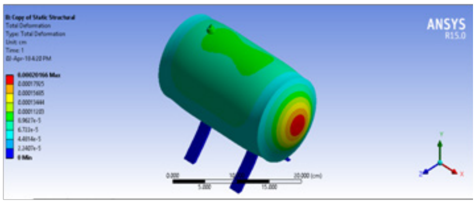


Maximum Total Deformation (1.008 e^{-7}m)

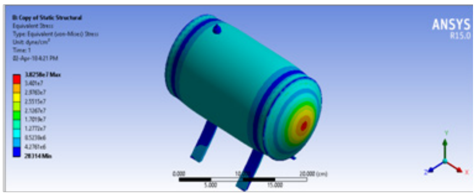


Maximum Equivalent von misses stress ($1.05e^{6}N/m^{2}$)

At 20 bar Pressure:



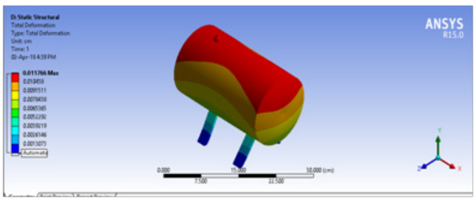
Maximum Total Deformation ($1.9e^{-7}$m)



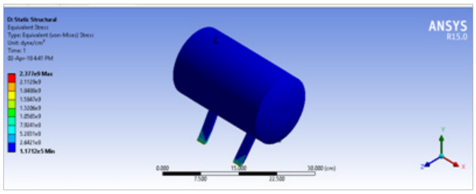
Maximum Equivalent von misses stress ($3.4e^{6}N/m^{2}$)

To suit the real-world conditions, the engine temperature and atmosphere Temperature have been taken into consideration. The analysis is done with steady-state thermal in ANSYS, and results are feed to static structural analysis to accomplish a perfect real-world conditions.

At 10 bar Pressure with 60°C temperature:

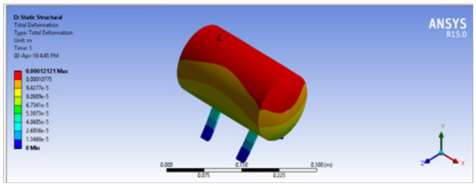


Maximum Total Deformation (1.045 e^{-7}m)

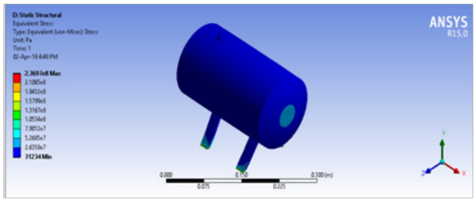


Maximum Equivalent von misses stress ($2.311e^{6}N/m^{2}$)

At 20 bar Pressure with 60°C temperature:



Maximum Total Deformation (2.12 e^{-7}m)

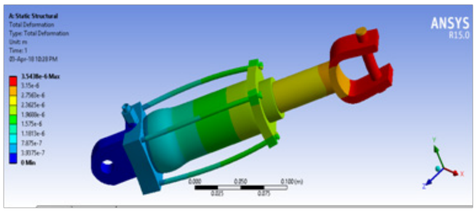


Maximum Equivalent von misses stress ($2.369e^{6}N/m^{2}$)

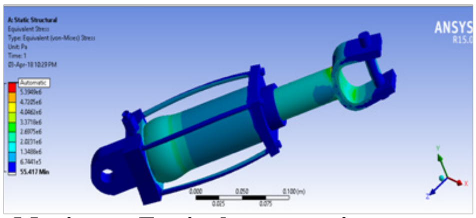
Analysis of Pneumatic Cylinder

In the same way as pressurized containers, the Pneumatic cylinder is also put into various tests in analysis to ensure everything is in the normal limit.

At 10 bar Pressure and 1000N of Force:

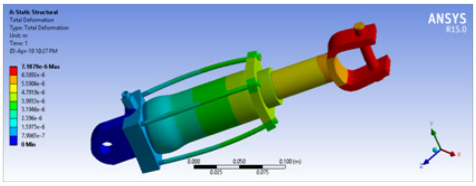


Maximum Total Deformation (3.54 e^{-6}m)

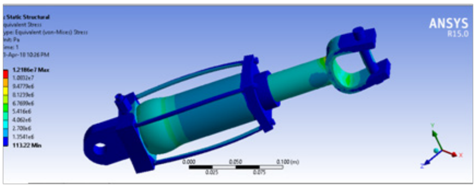


Maximum Equivalent von misses stress ($5.394e^{6}N/m^{2}$)

At 20 bar Pressure and 2000N of Force:



Maximum Total Deformation (7.187 e^{-6}m)



Maximum Equivalent von misses stress ($1.218e^{7}$N/m^{2})

The analysis in the Ansys 15.0 shows the Pneumatic cylinder is safer even during the pressure and force higher than the normal operating condition.

Crash Analysis

The force of the impacting car is taken into account by considering the mass and velocity of the vehicle. The force of the vehicle is applied to our innovation developed smart seat equipped car, to analyze how much the system is helpful to reduce the impact in cars and save life. The analysis is done at the basic level taking forces from the impacting car alone due to available resources in hand.

Force of 50kmph car with 1100 mass:

Mass of the car = 1100/9.81 kg (normal weight of the hatchback)
= 112.13kg

The velocity of the car = 50 kmph (Testing speed in NCAP)
= 13.88m/s

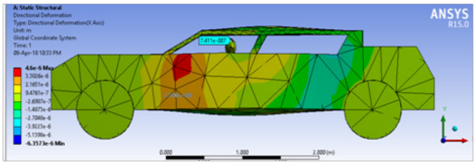
Force of the impacting vehicle F = (mv2/2)/d N

d = distance the vehicle has shrunken after impact
= 0.25m

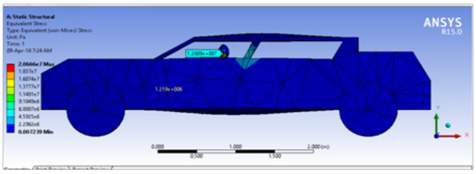
F = (112.13*14*14/2)/0.25 N
= 43954.96 N

The force of 45000 N is rounded off and applied to the near side of the vehicle

In a conventional car:



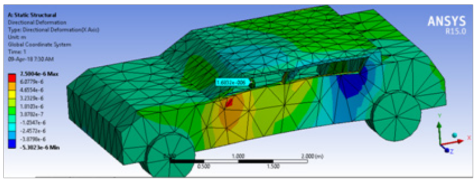
Total deformation in the head ($7.411e^{-007}$m)



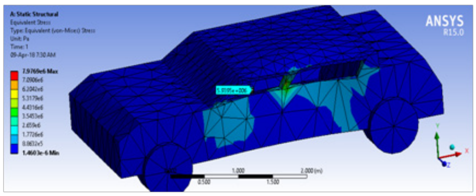
Maximum Equivalent von misses stress in the head ($7.2007e^{7}$N/m^{2})

In the smart seat car:

The deformation and equivalent von misses stresses are compared with the conventional car analysis, which shows a drastic difference in values. Hence if our project is implemented in cars, surely it can reduce the fatality rate in the side crash.



Total deformation in the head ($1.6001e^{-006}$m)



Maximum Equivalent von misses stress in the head ($5.9095e^{6}$N/m^{2})

Conventional Car Vs. Smart Seat Car

	Conventional Car	**Smart Seat Car**
Total deformation in head	$7.411e^{-007}$m	$1.6001e^{-006}$m
Maximum Equivalent von misses stress in head	$7.2007e^{7}$N/m^{2}	$5.9095e^{6}$N/m^{2}

Design Analysis

Pressure Measurement

1 Bar = 100Kpa = 100 KN/m^2 = 14.5 PSI

10 Bar = 1000Kpa = 1000 KN/m^2 = 145.03 PSI

Equation

$P = F/A$

$P = 10$ bar $= 1$ N/mm^2

Diameter of piston = d = 50mm

$A = (\pi/4) * (d^2)$

$= (\pi / 4) * (50 * 50)$

$= 1963$ mm^2

$P = F / A$

$1 = F / 1963$

$F = 1963$ N

$F = 200.17$ Kg.

The force needed to lift the seat along with the passenger is around 200 Kg at 10 bar Pressure. The pre-compressed pressure at 10 bar makes the pneumatic cylinder to actuate at the very moment of the impact and makes the driver or passenger seat to tilt and increases the distance between the impact vehicle and the victim.

Prototype of Smart Seat

Advantages & Limitations

Advantages

- Promises to save the innocent lives from the accident to the maximum extent
- As pneumatic components are not expensive if implemented, the costs of such safety systems will be quite low when compared to other existing safety features.
- Increases the distance between the impact vehicle and the victim.
- Reduces head, thorax, and pelvis impact drastically.
- It's a compact and very simple design adaptable to various manufacturer need and traditions
- Can be implemented as a mandatory safety feature in automobiles in upcoming Bharat Stage Norms

Limitations

- A moderate increase in the Production cost of the car due to additional equipment and researches for implementation.
- The pressure reservoir needs to be refilled after some time, like refilling the tires to avoid pressure drop.
- Low ground clearance cars need complex design under the seats because of low clearance between the seat and the floor
- Back seat passenger seats need to be designed innovatively from the conventional design.
- Seat belt pre-tensioner has to be mandatory to make possible the life-saving protector under the seats.

Conclusion

The innovation and technique that we have used for the fabrication ensure the protection of innocent lives of people and the safety of transportation. This fabrication will be a life saver and passive safety feature in vehicles both in terms of mathematically and at the design level. The analysis enlightens the amount of force and stresses reduced by our guardian. The limitation in low ground clearance cars can be overcome by X type seat arrangement, which shows the adaptability and customization of the Guardian beneath the seats. Amount of expenditure spent on accidents, loss of impeccable life, to increase the safety of the upcoming vehicle, and the foremost low-cost safety feature to help everyone to go for safety adoption. Our project stands to be a perfect solution to fulfill the above-mentioned criteria, and it will be a great wall against the side crash fatality rate if implemented as a mandatory safety feature in upcoming Bharat and euro Norms. The effort and our precious time that we lavished will pay off in protection of life and reduction in injury.

References

Fildes, B.N. et al. *Passenger Cars and Occupant Injury: Side Impact Crashes*, Monash University, 1994.

Kuppa, S. *Injury Criteria for Side Impact Dummies*, National Transportation Biomechanics Research Center and National Highway Traffic Safety Administration, 2004.

Mikusova, M. "Crash Avoidance Systems and Collision Safety Devices for Vehicle Occupants." *MATEC Web of Conferences,* vol. 107, 2017.

Milanowicz, M. "Numerical Analysis of Passive Safety Systems in Forklift Trucks." *Safety Science*, vol. 101, 2018, pp. 98-107.

Nolan, J. et al. "Factors Contributing to Front-Side Compatibility: A Comparison of Crash Test Results." *Stapp Car Crush Conference*, 1999.

Page, Y. et al. "The Evaluation of the Safety Benefits of Combined Passive and on-board Active Safety Applications." *Annals of Advances in Automotive Medicine*, vol. 53, 2009, pp. 117-127.

Schneider, S. et al. "Effectiveness of Thorax & Pelvis Side Airbag for Improved Side-impact Protection." 19th International Technical Conference on the Enhanced Safety of Vehicles (ESV), 2005.

Thomas, P. et al. "Priorities for Enhanced Side Impact Protection in Regulation 95 Compliant Cars." *Enhanced Safety of Vehicles (ESV) Conference*, 2009.

Waghe, Rahul and Gajjal, S.Y. "Study of Active and Passive Safety Systems and Rear-view Mirror Impact Test." *SSRG International Journal of Mechanical Engineering,* vol. 1, no. 3, 2014, pp. 5-10.

Author Details

P. Sabarinath, *Associate Professor, Department of Mechanical Engineering, K.L.N. College of Engineering, Pottapalayam, Sivagangai, Tamil Nadu, India,* ***Email ID****: jananisabari@gmail.com*