

# Comparative Analysis of Conventional and Inflatable Seat Belt

Sanjay R. Lohar, Narendra D. Vanjara, Rishi A. Dhokad, Sumit S. Pawar Ketaki P. Kini

*Abstract- Cars are increasing day by day on street, that is more and more people of different age groups are using a passenger car for transportation. Safety of these occupants is and important aspect of car design, also new safety features are becoming more important as awareness of safety and market competitiveness of manufacturers is increasing. Seatbelts are generally used for restraining occupants during a collision but since long time no innovations have been made in this system. Seatbelts also cause various injuries in severe conditions to adults and also to children, called seatbelt syndrome (Contusion of anterior abdominal wall caused by lap seat belts, which may produce lumbar spine fractures with horizontal splitting of the vertebral body and posterior arch, trauma to bowel, vessels, spleen and liver)<sup>1</sup>. Thus to combat seatbelt syndrome and improve current seatbelt and safety we introduce inflatable seat belts. These are a combination of seat belt and airbag which helps distributing force on the body of the wearer to a greater area during collision, thus preventing localization of forces causing organ damage. It also can be used where using air bags is not possible and they are cheaper in operation and maintenance than airbags. This paper investigates the difference between the regular seatbelts and inflatable seatbelts by finite element analysis using ANSYS.*

*Index Terms— Car Accidents, Inflatable Seatbelt, Passenger Safety, Seat Belt Syndrome.*

## I. INTRODUCTION

Use of conventional seatbelt may cause a number of injuries to the passenger wearing it, known as the seat belt syndrome.

Seatbelt syndrome: injuries that occur in a car accident as a result of wearing a seatbelt. The range on severity of injuries is variable. Various damages due to this are

- Abdominal organ damage
- Bowel rupture
- Abdominal wall injuries
- Ruptured liver
- Blood vessel trauma
- Chest trauma
- Fractured sternum
- Myocardial contusion
- Spine fractures

To combat this inflatable seat belt are used. Inflatable Seat belt utilizes tubular inflatable bladders contained within an outer cover.

**Manuscript Received on April 2015.**

**Prof. Sanjay R. Lohar**, Mechanical Department , Mumbai University, Vidyavardhini's College of Engg. And Technology, Vasai, India.

**Narendra D. Vanjara**, Mechanical Department , Mumbai University, Vidyavardhini's College of Engg. And Technology, Vasai, India.

**Rishi A. Dhokad**, Mechanical Department , Mumbai University, Vidyavardhini's College of Engg. And Technology, Vasai, India.

**Sumit S.Pawar**, Mechanical Department , Mumbai University, Vidyavardhini's College of Engg. And Technology, Vasai, India.

**Ketaki P.Kini**, Mechanical Department , Mumbai University, Vidyavardhini's College of Engg. And Technology, Vasai, India.

When a crash occurs the bladder inflates with a gas to increase the area of the restraint contacting the occupant and also shortening the length of the restraint to tighten the belt around the occupant, improving the protection. The insatiable sections may be shoulder only or lap and shoulder. Inflatable seat belts are designed to provide additional protection for passengers where employing air bags are not feasible. Inflatable rear seat belts spreads force over five times more the area of the body, than conventional seat belts.

Thus the pressure from the collision doesn't concentrate in one specific area of the body viz. chest, head, and neck. Before collision the setup is similar to conventional seat belt, but as the collision takes place, the seatbelt automatically busts out and inflates to act as a cushion.

## II. CONSTRUCTION AND WORKING

The main objective is to inflate the belt's airbag with cold compressed gas. Thus the system consists of solenoid valve, cylinder (container), buckle with passage for compressed air, and airbag in belt.

The compressed gas container is connected to the airbag via buckle, designed along the line of quick release pneumatic coupler.

In case of collision the sensors on the front bumpers sends the signal to the ECU regarding the collision, which in turn activates the solenoid valve by sending electricity from the battery to the valve. This opens the valve the thus the pressure on the gases in the cylinder is released and it rushes out of cylinder, the gas moving through the valve and buckle reaches the balloon type seatbelts. This sudden rush of gas leads to the inflation of the belt. This inflation increases the surface area of the belt by 3 times as compared to normal seat belt. Thus this increase in the surface area helps distribute the weight of the body on larger surface area and thus reducing reaction force on a single part of body

## III. FINITE ELEMENT ANALYSIS

Analysis of the system is performed computationally using analysis software. We are using ANSYS for this purpose. The analysis will be carried out in two parts viz.

Part 1: First analysis is carried out on conventional seat belt. Forces on a body is calculated using the dimensions of the conventional belt

Part 2: second the analysis is carried out on inflatable seat belt considering the increased contact area

## IV. RESULTS

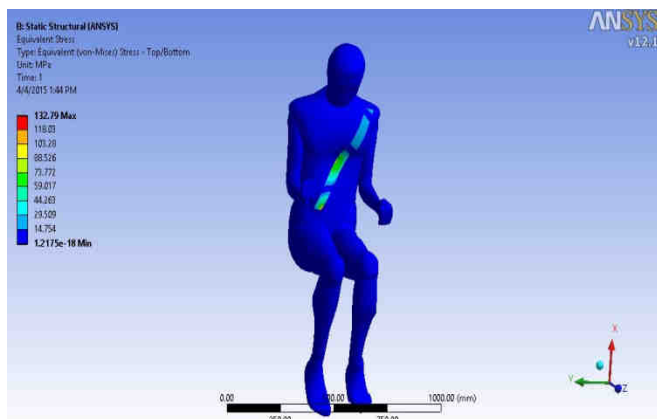


Figure-1 Von mises stress in conventional seat belt

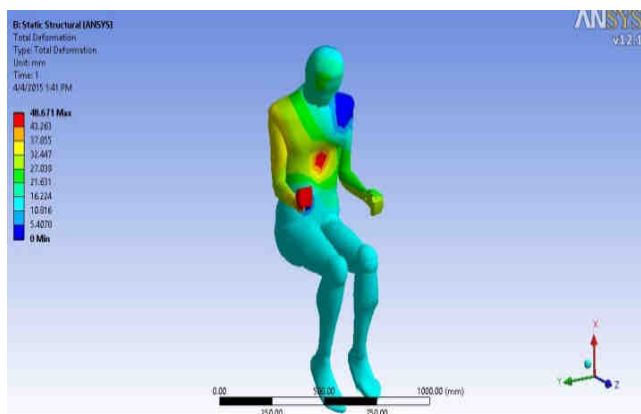


Figure-2 Deformation in conventional seatbelt

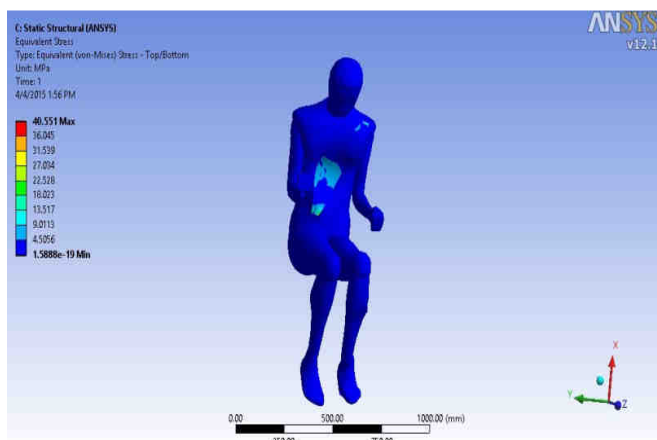


Figure-3 Von mises stress in Inflatable seat belt

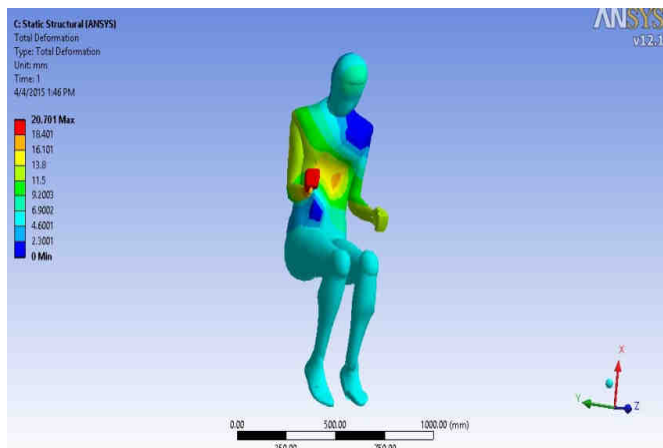


Figure-4 Deformation in Inflatable seat belt

Table-1 comparison of conventional and inflatable seat belt

PARAMETER	CONVENTIONAL SEAT BELT	INFLATABLE SEAT BELT
VON MISES STRESS (max)	132.79 mpa	40.55 mpa
DEFORMATION (max)	48.67 mm	20.701 mm

## V. CONCLUSION

From Table-1 it can be seen that there is a considerable difference between the von mises stress and deformation of the regular and inflatable seat belt. Thus in case of extreme conditions it can help in saving human life. Since components used for the system are cheaper and easy in construction compared to air bags they can be employed in cheap passenger cars thus improving safety in all segments. Since container can be easily refilled with compressed gas replacement is easy in case of deployment of the system compared to airbags where the replacement is tedious and costly

## REFERENCES

1. Seat Belt Syndrome. (n.d.) *Segen's Medical Dictionary*. (2011). Retrieved April 22 2015 from <http://medical-dictionary.thefreedictionary.com/Seat+Belt+Syndrome>

**Prof. Sanjay R. Lohar**, Mechanical Department , Mumbai University, Vidyavardhini's College of Engg. And Technology, Vasai, INDIA.

**Narendra D. Vanjara**, Mechanical Department , Mumbai University, Vidyavardhini's College of Engg. And Technology, Vasai, INDIA.

**Rishi A. Dhokad**, Mechanical Department , Mumbai University, Vidyavardhini's College of Engg. And Technology, Vasai, INDIA.

**Sumit S.Pawar**, Mechanical Department , Mumbai University, Vidyavardhini's College of Engg. And Technology, Vasai, INDIA.

**Ketaki P.Kini**, Mechanical Department , Mumbai University, Vidyavardhini's College of Engg. And Technology, Vasai, INDIA.