International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 90-96 www.ijaem.net ISSN: 2395-5252

Analysis of Vehicle Crash Box to Improve Passengers Safety with Shape and Material Optimization

Amrutkar Ankush Rajendra
Ahire Trupti Hemant,Ahire Sanchit Vilas
Guided by: Prof. Y.S. Khadke
Matoshri College OF Engineering And Research Centre, Nashik.

Submitted: 10-06-2021 Revised: 23-06-2021 Accepted: 26-06-2021

ABSTRACT:
The rapid growth in the on road vehicles leads to the increase in road accident day by day which causes loss to both vehicle as well as passenger. Hence nowadays vehicles are provided with number of safety features like ABS, Air bags, Stability control, Parking sensors, Crash Box, etc. out of which the Crash Box is a safety device provided in vehicles generally between front bumper and vehicle chassis in order to reduce the impact of collision. Due to safety measures the crash box is present in almost all vehicles and researchers are continuously upgrading the shape and material of crash box in order to improve the vehicle and passengers safety. Considering the safety of vehicle and passengers, the author proposed a work on analysis and development of vehicle crash box of square and circular shape using two different materials mainly Aluminum Alloy, and Mild Steel and the analysis is made using ANSYS subjected to same impact loading condition equivalent to the frontal collision condition of vehicle and the deformation and energy absorption during collision is measured analytically and material for crash box with low deformation and high energy absorption is selected as an optimum material of crash box with improved safety.

Keywords: ANSYS, Crash Box, Collision, Deformation, Safety, Square Shape, etc.

I. INTRODUCTION

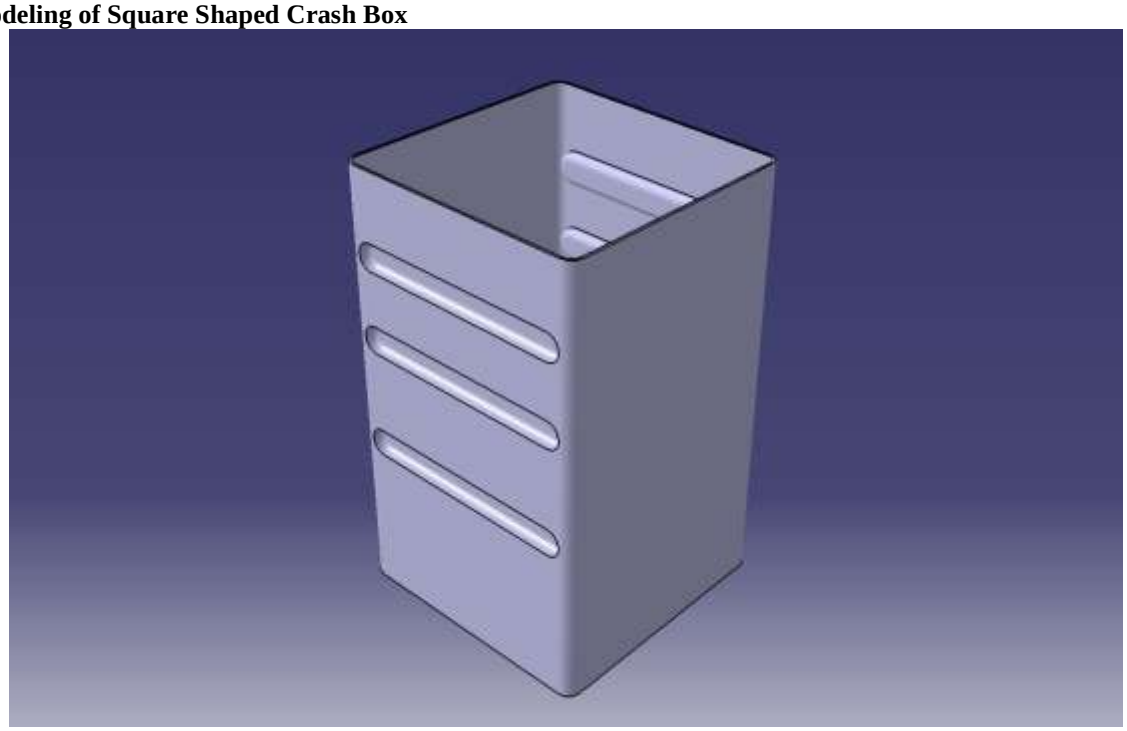
The first priority of drivers and passengers related to vehicle is safety. People expect driving or riding in cars to be very safe. A vehicle is expected to provide adequate protection to driver and passengers also from a serious accident. The goal of engineering effort in the field of crashworthiness is to satisfy, or, to the extent possible, exceed the safety requirements mandated by the Federal Motor Vehicle Safety Standards (FMVSS) and administered by the National Highway Traffic Safety Administration (NHTSA). To protect the occupants of a car, there are many new tangible safety features such as airbags, crash box, seat belts, ABS brakes. Surviving a crash is all about kinetic energy. When your body is moving, it has a certain amount of kinetic energy. After the crash, when you come to a complete stop, you will have zero kinetic energy. To minimize risk of injury, you would like to remove the kinetic energy as slowly and evenly as possible. In vehicles in frontal collisions, the body structure performs different functions. The front is designed to act as a crumple zone, managing and absorbing crash energy by collapsing in a controlled manner, so that the impact affects the car and not the occupants. A typical vehicle front crash box.

II. MODELING OF VEHICLE CRASH BOX FOR SHAPE OPTIMIZATION

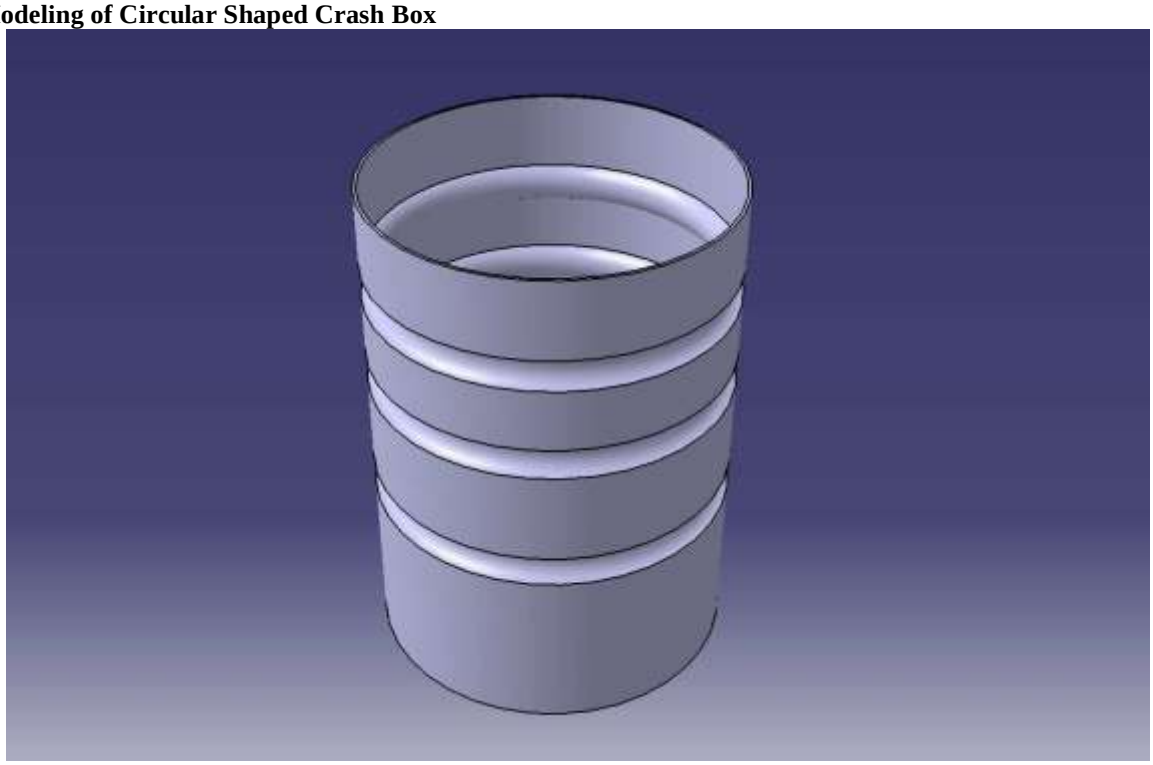
To reduce the deformation and to improve the energy storage capacity of the vehicle crash box first the shape analysis is performed. For the same the four different shapes of crash box are made such as square, rectangular, circular and trapezoidal. The shapes are formed by keeping the length and volume of the geometry constant. The different shaped crash boxes are modeled using CAD package like Catia and imported into the ANSYS for the Analysis. While modeling the crash box attention is given that the slots on crash boxes are to be provided at the same distance.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 90-96 www.ijaem.net ISSN: 2395-5252

Modeling of Square Shaped Crash Box



Modeling of Circular Shaped Crash Box



A) Analysis of Crash Box for Shape optimization

Once the crash box model having different shapes are developed using CAD then they are imported to the ANSYS for analysis work. First the object is fixed from one side then the force is applied and the result for deformation and energy absorption is evaluated.

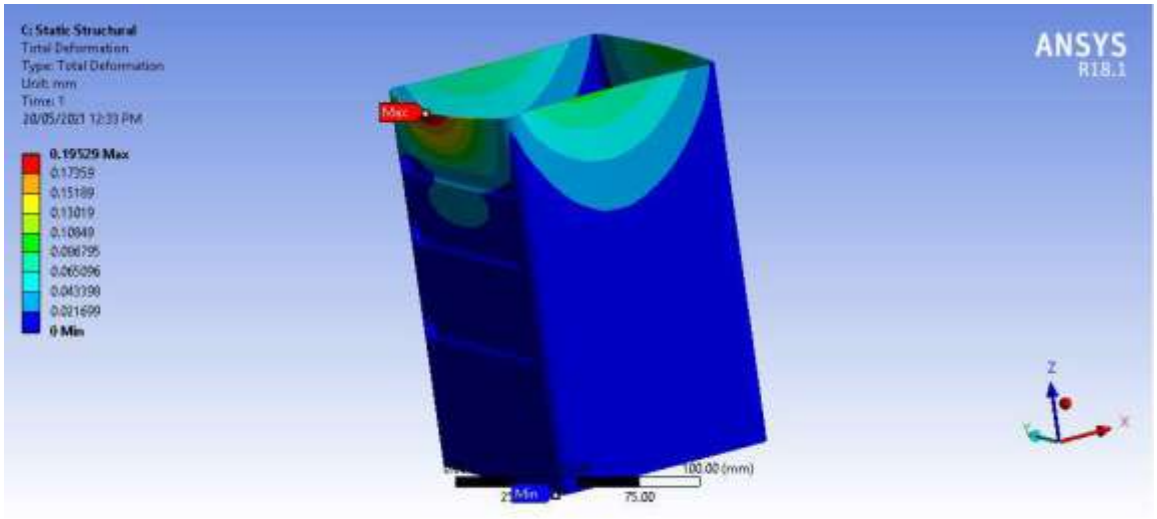
The analysis of crash box mainly includes two parts one is for total deformation and the other

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 90-96 www.ijaem.net ISSN: 2395-5252

is for strain energy. The impact loading condition is specified by considering that the vehicle of 200kg is running at 40Km/Hr collides with stationary objects and return back at 5Km/Hr within a short period of time 0.5 sec. Hence the force of collision is 5004N

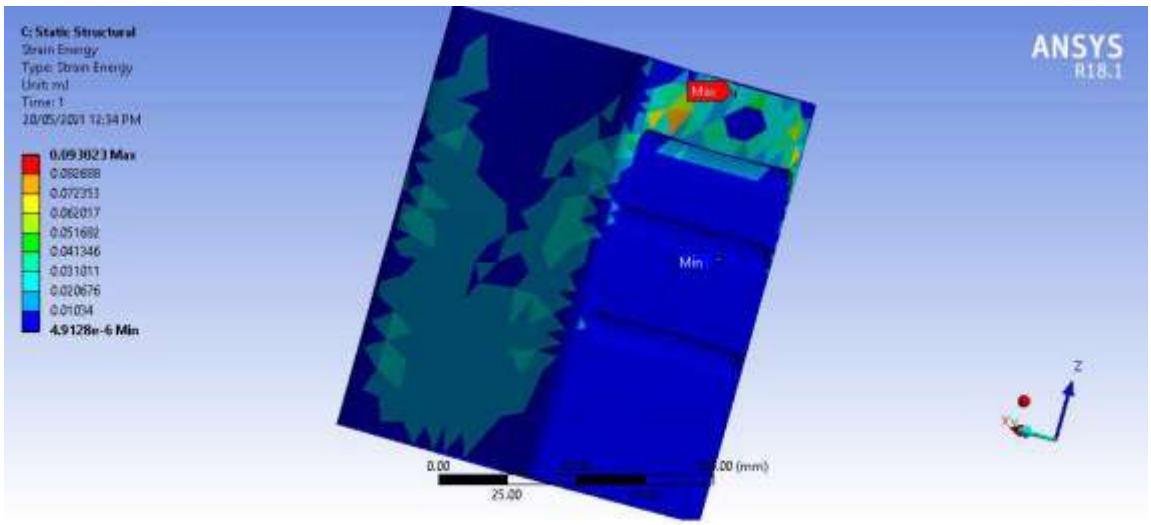
- **Analysis of Square Shaped Crash Box**

a) Total Deformation



Crash Box Shape	Max. Total Deformation (mm)
Square	0.19529

b) Strain Energy

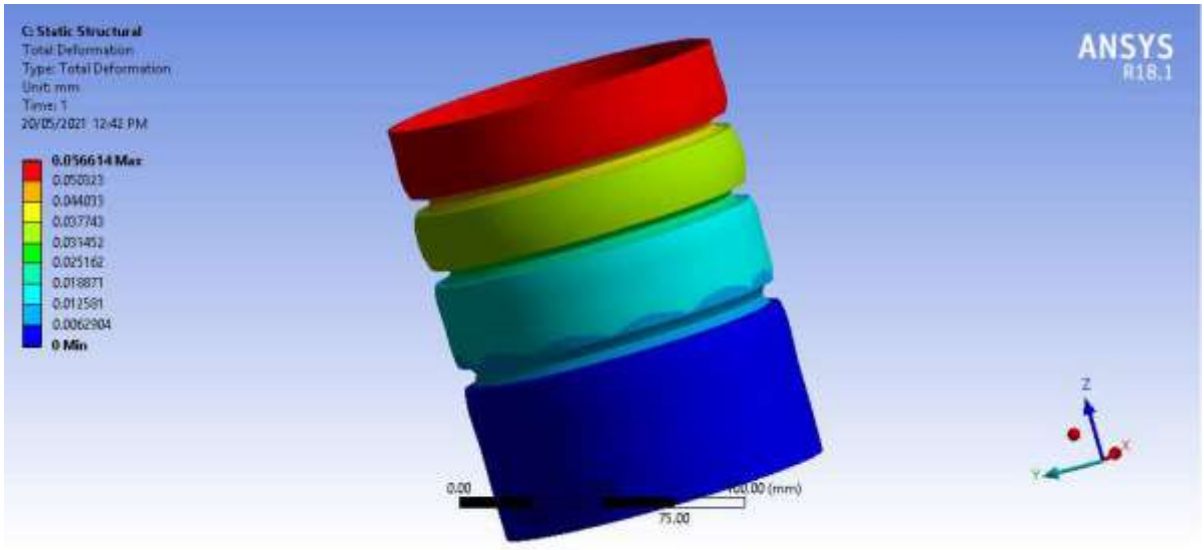


International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 90-96 www.ijaem.net ISSN: 2395-5252

Crash Box Shape	Strain Energy (m J)
Square	0.093023

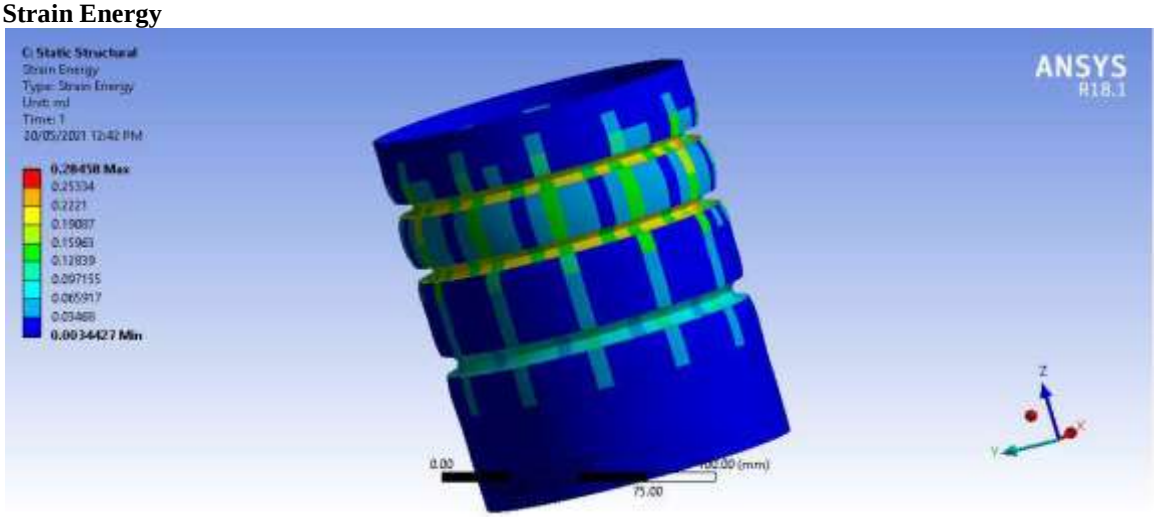
- **Analysis of Circular Shaped Crash Box**

a) Total Deformation



Crash Box Shape	Max. Total Deformation (mm)
Circular	0.056614

b) Strain Energy



Crash Box Shape	Strain Energy (J)
Circular	0.28458

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 90-96 www.ijaem.net ISSN: 2395-5252

III. RESULT AND DISCUSSION

The analysis comparison of crash box for deformation and also for strain energy. It can be shown that the circular shape crash box is optimum shape as the deformation is comparatively lower than the other shape with maximum deformation.

Shape	Deformation	Strain Energy
Circular	0.056614	0.28458
Square	0.19529	0.093023

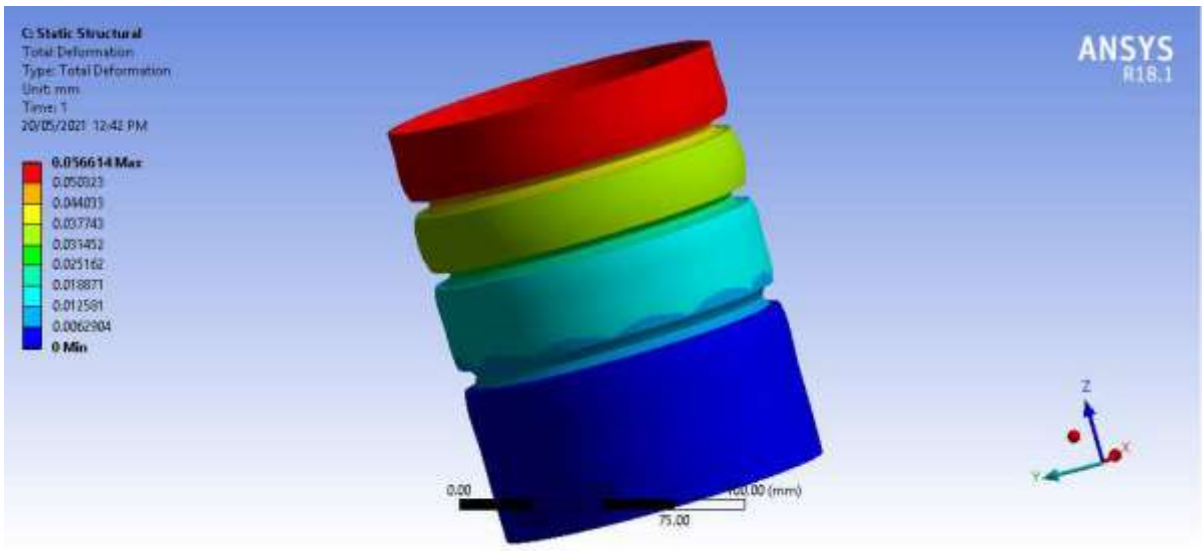
As per the above deformation we consider curcular shape for material optimization.

B) Analysis OF Circular Crash Box For Material Optimization

After shape analysis, to reduce the deformation and to improve the energy storage capacity of the vehicle crash box the material optimization analysis is performed.. For the same circular shape of crash box mild steel and aluminum are used .

Analysis of circular Crash Box for Mild Steel

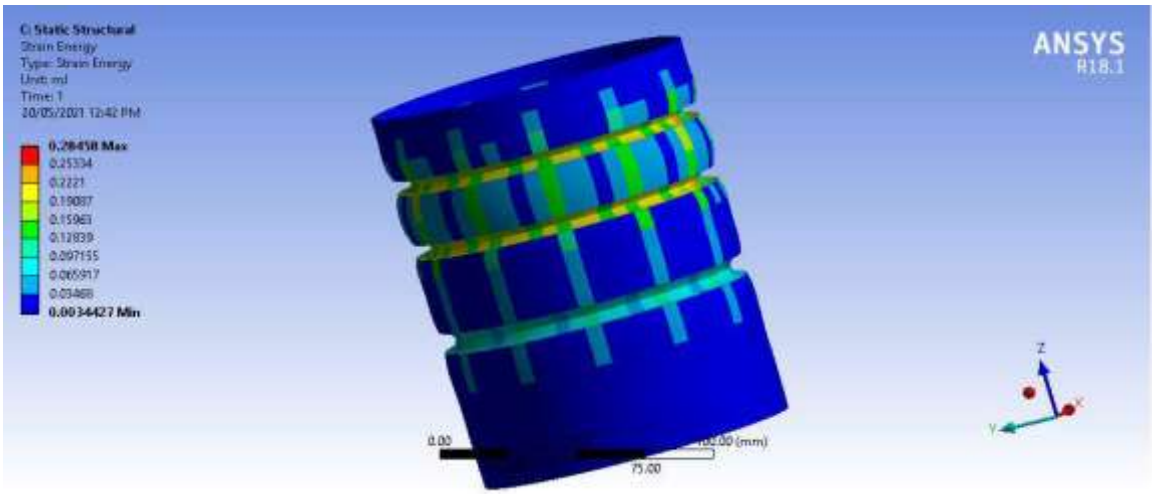
a) Total Deformation



Crash Box Shape	Max. Total Deformation (mm)
Circular	0.056614

b) Strain Energy

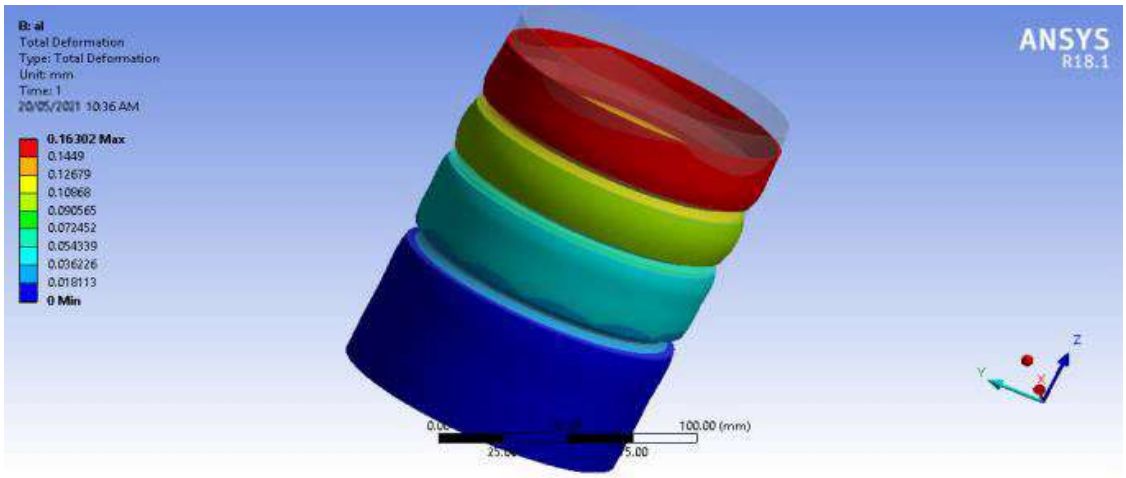
International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 90-96 www.ijaem.net ISSN: 2395-5252



Crash Box Shape	Strain Energy (J)
Circular	0.28458

- **Analysis Of Circular Crash Box For Aluminum**

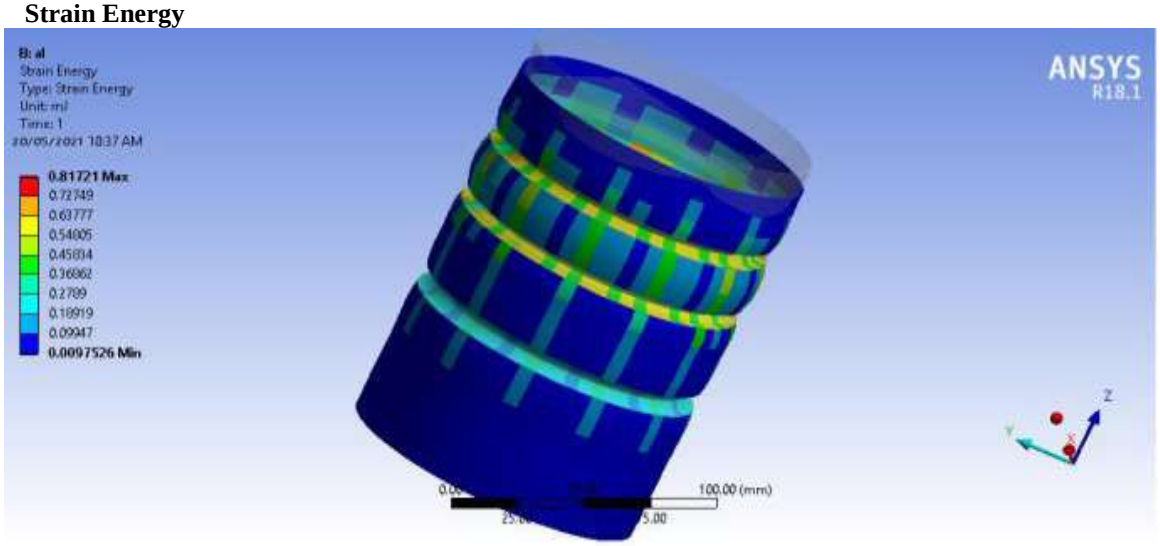
a) Total Deformation



Crash Box Shape	Max. Total Deformation (mm)
Circular	0.16302

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 90-96 www.ijaem.net ISSN: 2395-5252

b) Strain Energy



Crash Box Shape	Strain Energy (m J)
Circular	0.81721

✓ **Result and Discussion**

The table shows the Total Deformation and Strain Energy value for two crash box of different material.

Material	Total Deformation	Strain Energy
Mild Steel	0.056614	0.28458
Aluminum	0.16302	0.81721

It is clear from the table that the both material shows different values for deformation and strain energy for the same loading condition. It is observed that the total deformation of Mild Steel crash box is comparatively lower than Aluminum composite but the strain energy is also lower. During the vehicle frontal collision the deformation factor is mainly considered than that of Strain energy. Hence the lower deformation crash box material is selected as an optimum material. Hence the 1018-mild steel crash material is proposed for improved safety of vehicle.

IV. ACKNOWLEDGMENT

I am thankful to all of those with whom I have worked for successful completing of the work. I am very thankful to Prof.Y.S.Khadke for his kind support and sharing his valuable time. Each of the members of my project grouo has provided me extensive personal and professional guidance

REFERENCES

[1]. Chaudhari C.D., Joshi A.P., Waghmare S.A. "Crash test for 40% offset frontal bumper car analysis using CAE"2013.
[2]. https://webthesis.biblio.polito.it/
[3]. https://webthesis.biblio.polito.it/7119/1/tesi.pdf
[4]. http:// ijesc.org
[5]. Study of a crash box design optimized for a uniform Load profile A. Segade1(*), A. Bolaño1, J.A. López-Campos1, E. Casarejos1, J.R. Fernandez2, J.A. Vilán1
[6]. Shape Optimization of a Vehicle Crash-box Marcus Redhe, Engineering Research Nordic AB Larsgunnar Nilsson, Engineering Research Nordic AB Fredrik Bergman, Saab Automobile AB Nielen Stander, LSTC