Self Project

Shape optimisation of vehicle crash box by impact testing in
Abaquas.

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Introduction

- Crash box is one of the most important part for a safe passenger vehicle.
- The main function of crash box is to absorb impact load.
- Since all the impact load is absorbed by crash box. Less force transferred to the occupants.
- Crash box is a ub shaped object which is located near bumper and chasis .
- Crash box in automobiles helps to reduce the impact energy during the collisions.
- During impact the shock energy is converted into strain energy by crumpling of the crash box.
- Crash box plays very important role for safety of the vehicle and the reduction of repair cost when the vehicle meet the low speed collisions.
- The crash box are designed in such a way that it does not bend during collision .
- Instead the crash box should crumple.
- If the crash box bends ,then it absorb lesser energy and the shock load will be transferred to other parts and the occupant.

Various crash box shapes in practice

1. Square
2. Circle
3. Rectangular
4. Hexagon
5. Octagon


Square   Circle

Rectangle   Hexagon   Octagon
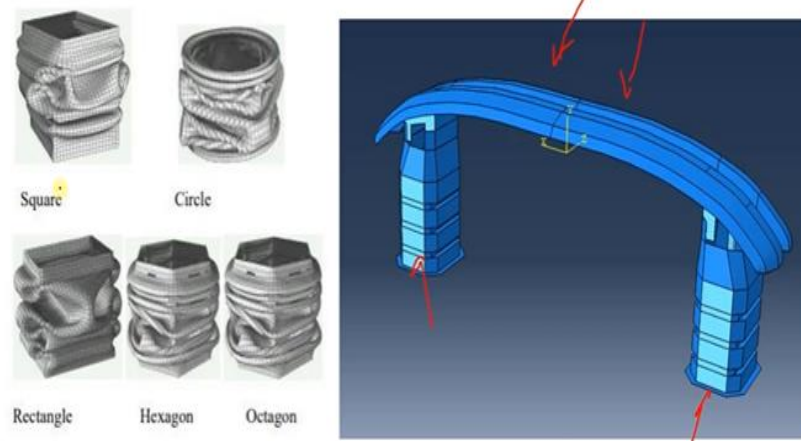
▲ Various Crush Box Shapes and Practice Models

Principle of Shape optimisation by impact testing

In this analysis we provide a certain amount of deformation along the length of the crash box by the application of certain impact load . we optimise the shapes by comparing the maximum strain energy absorb by the crash box and also the stress produce .

Practical testing representation of Impact test:
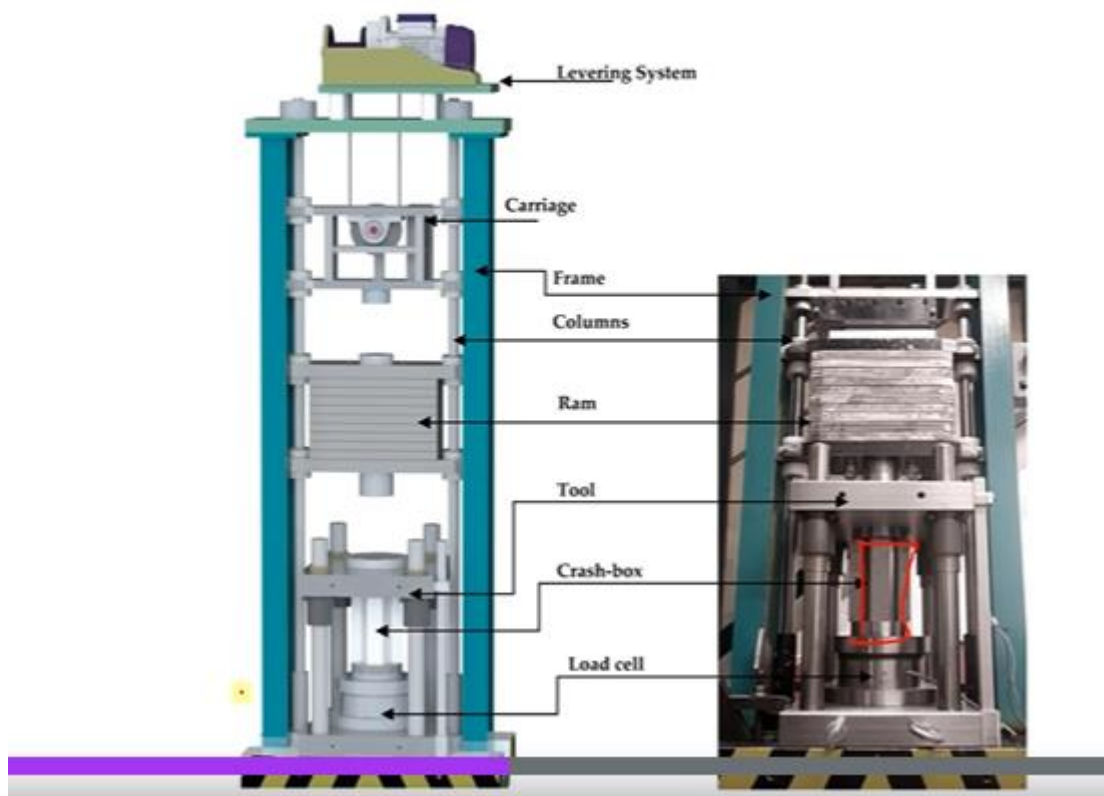
Material properties for aluminium used for Impact testing

Desnsity =2900Kg/m^3

 Self Friction corfficient=0.2

Load applied=100Kg

Dimensions of rigid walls are same for all cases : 50*50 all dimensions are in mm.

Elastic Properties of Aluminium	
Modulus of Elasticity	69000Mpa
Poissoins ratio	0.29

Plastic properties of Aluminium	
Yield stress(Mpa)	Plastic strain
120	0
160	0.05
200	0.07
220	0.1
240	0.15

Results and discussion

1. Square crash box analysis

Materail=Aluminium, dimension for box=150*25*25 , All dimensions are in mm.
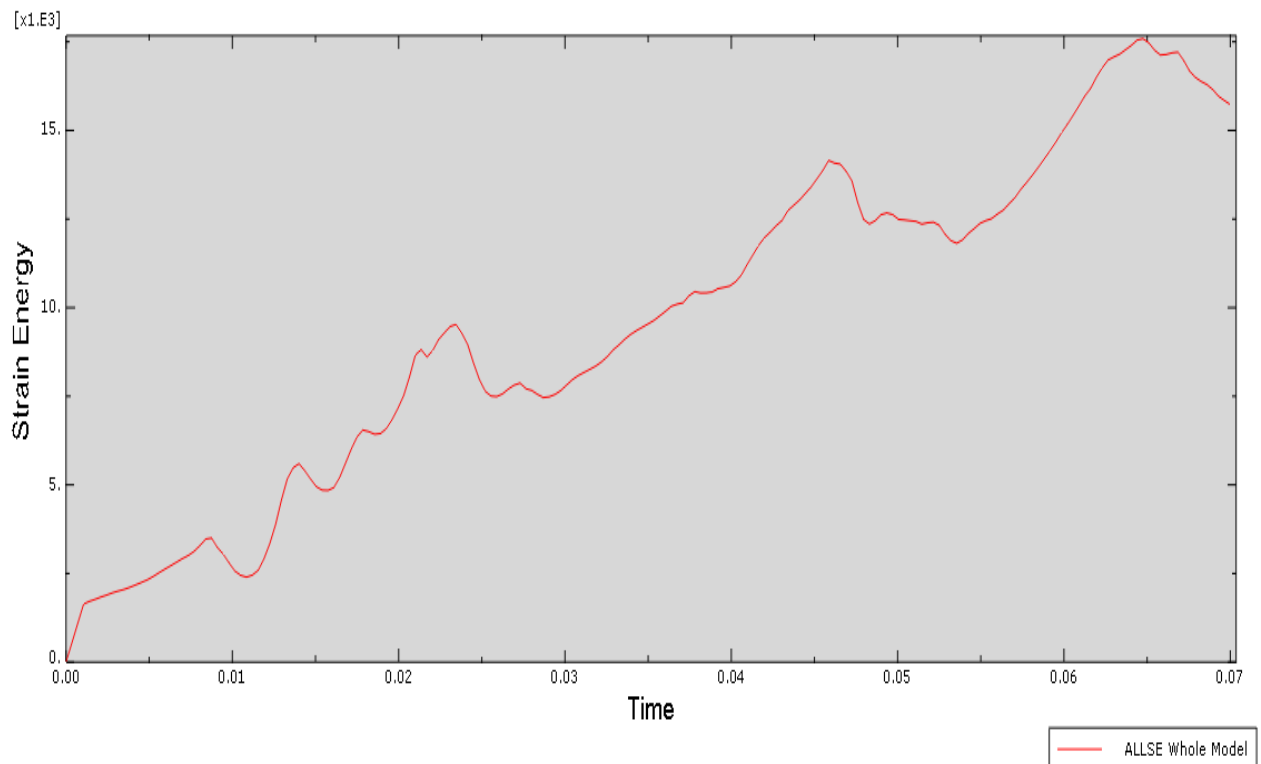
Square crash box Isometric view:
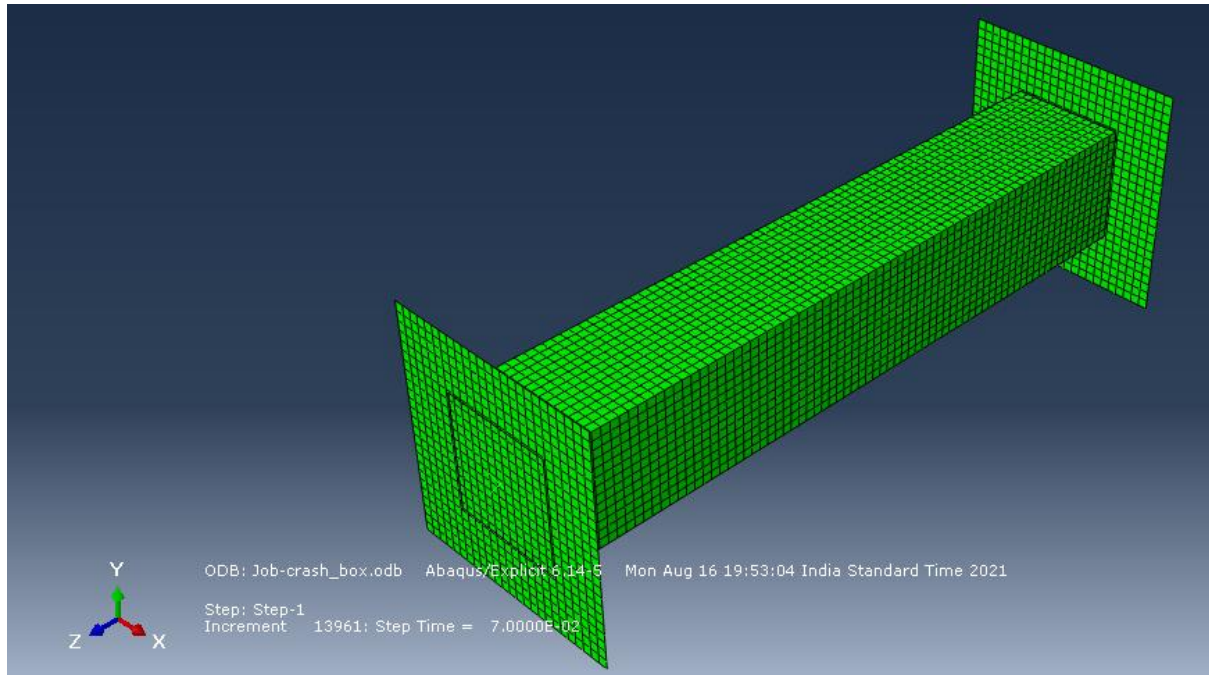
Square Crash box deformation representation:
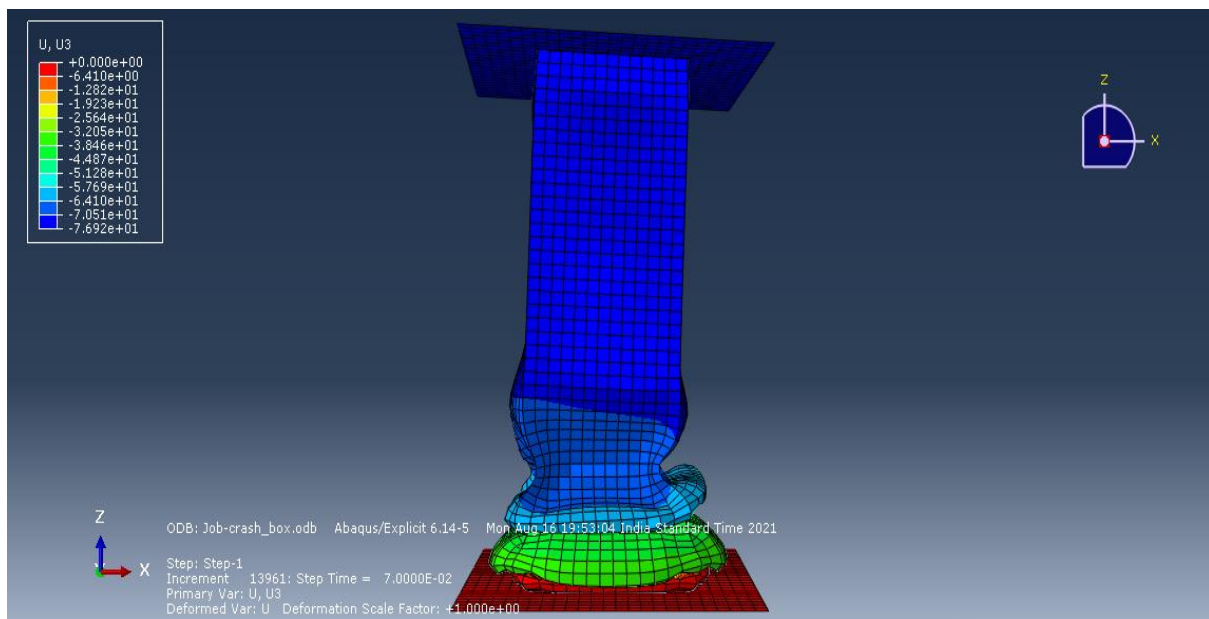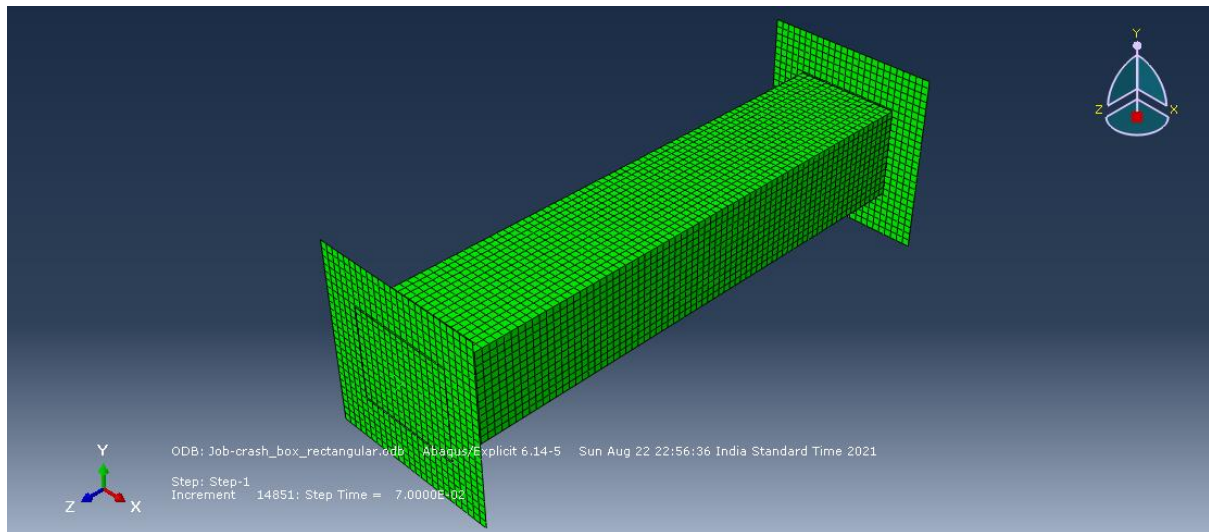
Square Crash box Stress representation:
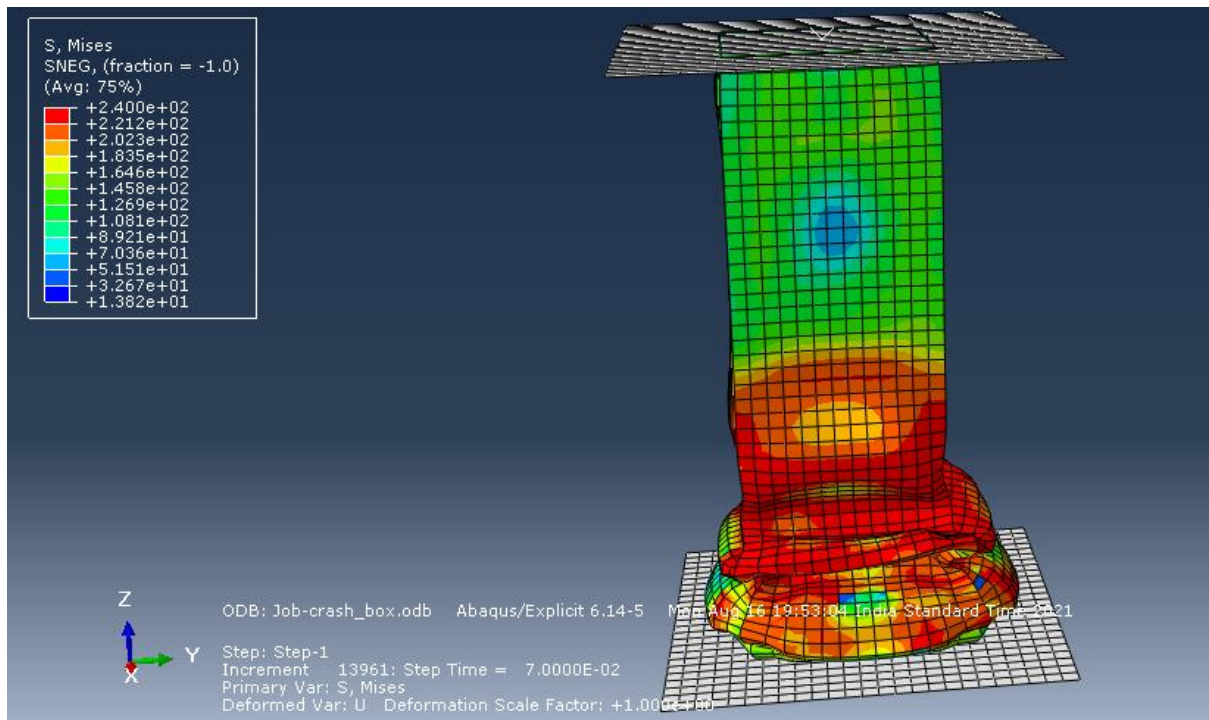
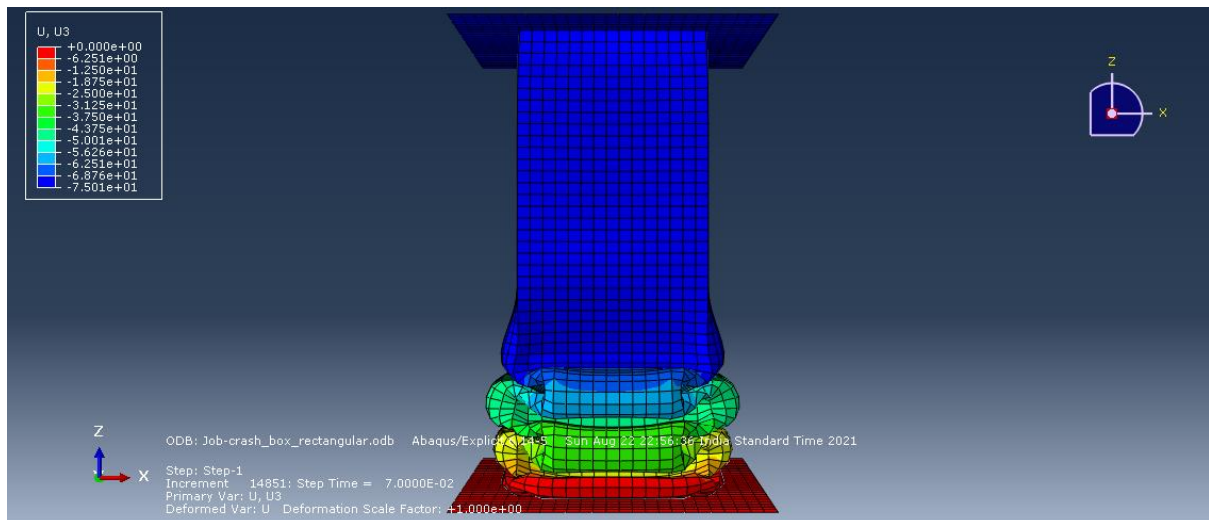**Strain Energy vs time representation during deformation:**

2. Rectangular crash box analysis:

Dimension : 150*30*25 all dimensions are in mm.
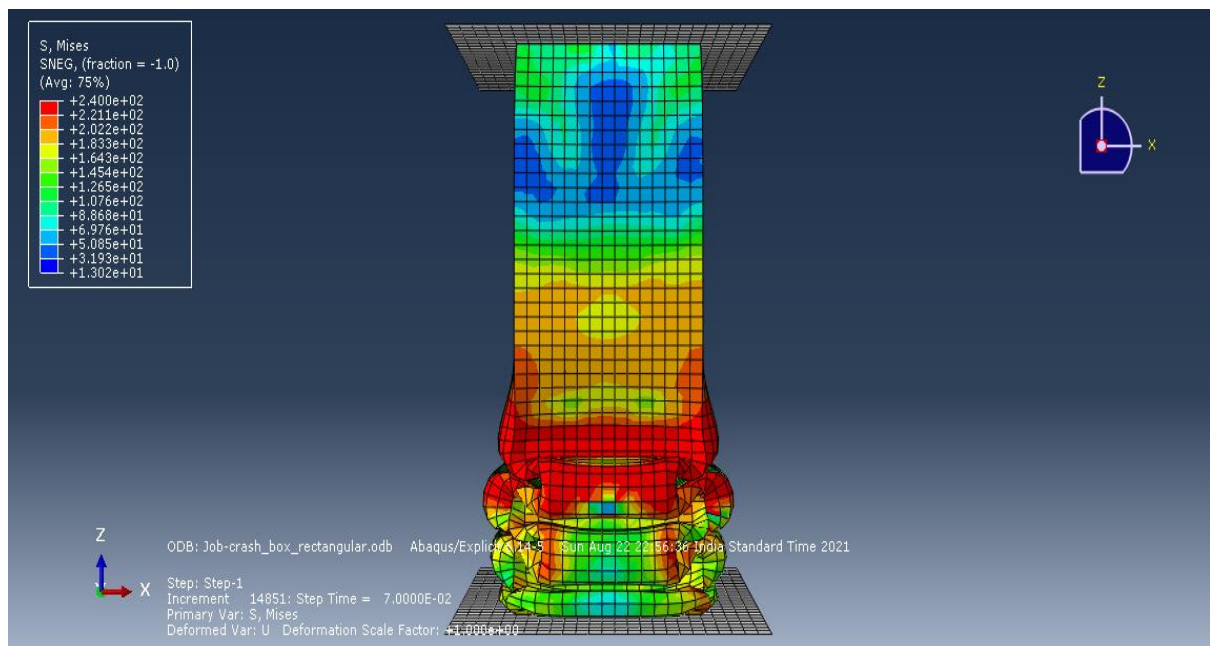
Rectangular crash box Isometric view:
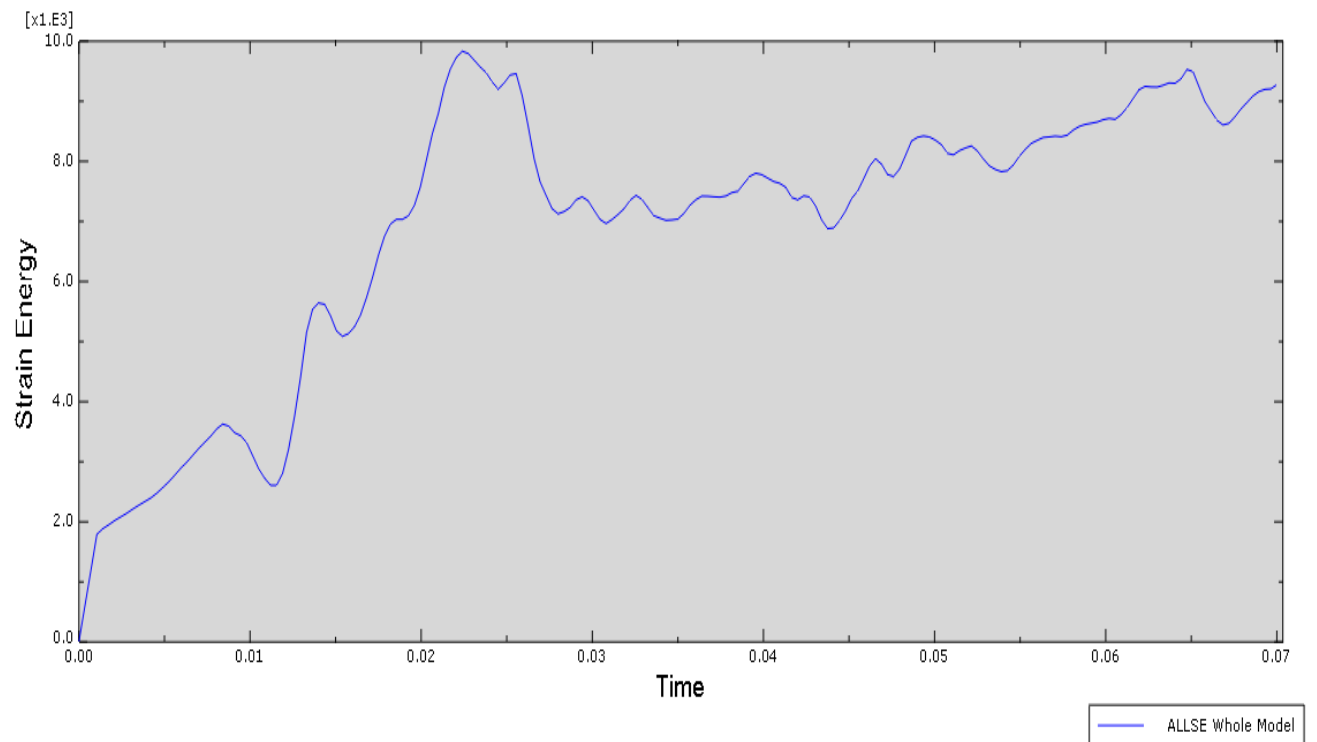
Deformation Crash box deformation representation:
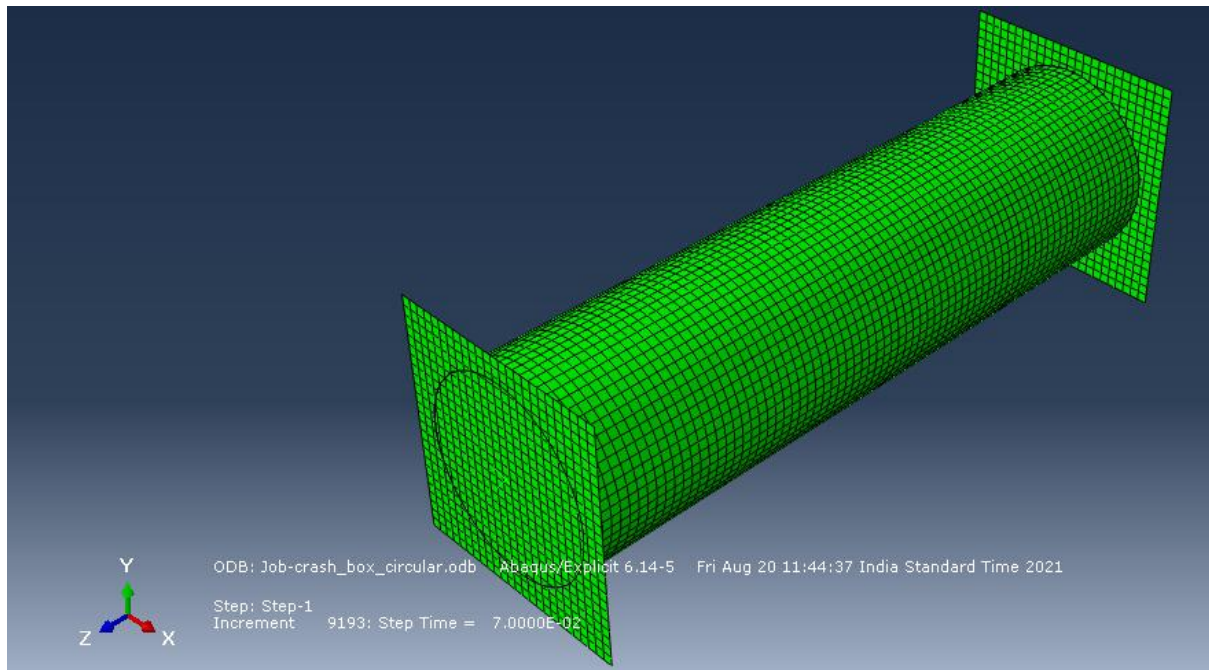
Rectangular Crash box Stress representation:

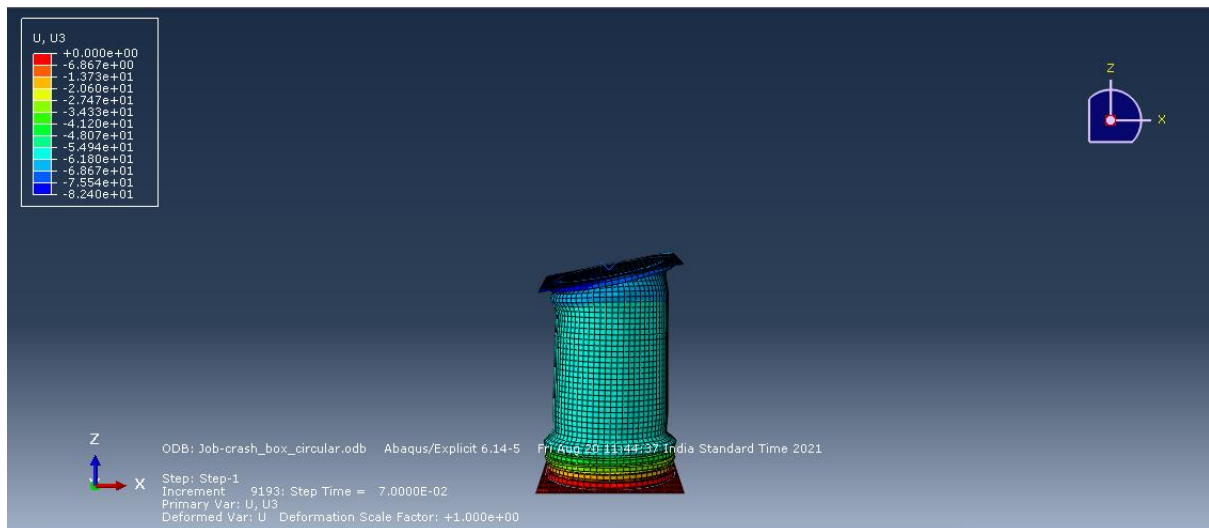**Strain Energy vs time representation during deformation:**

3. Circular crash box analysis:

Diameter=30mm

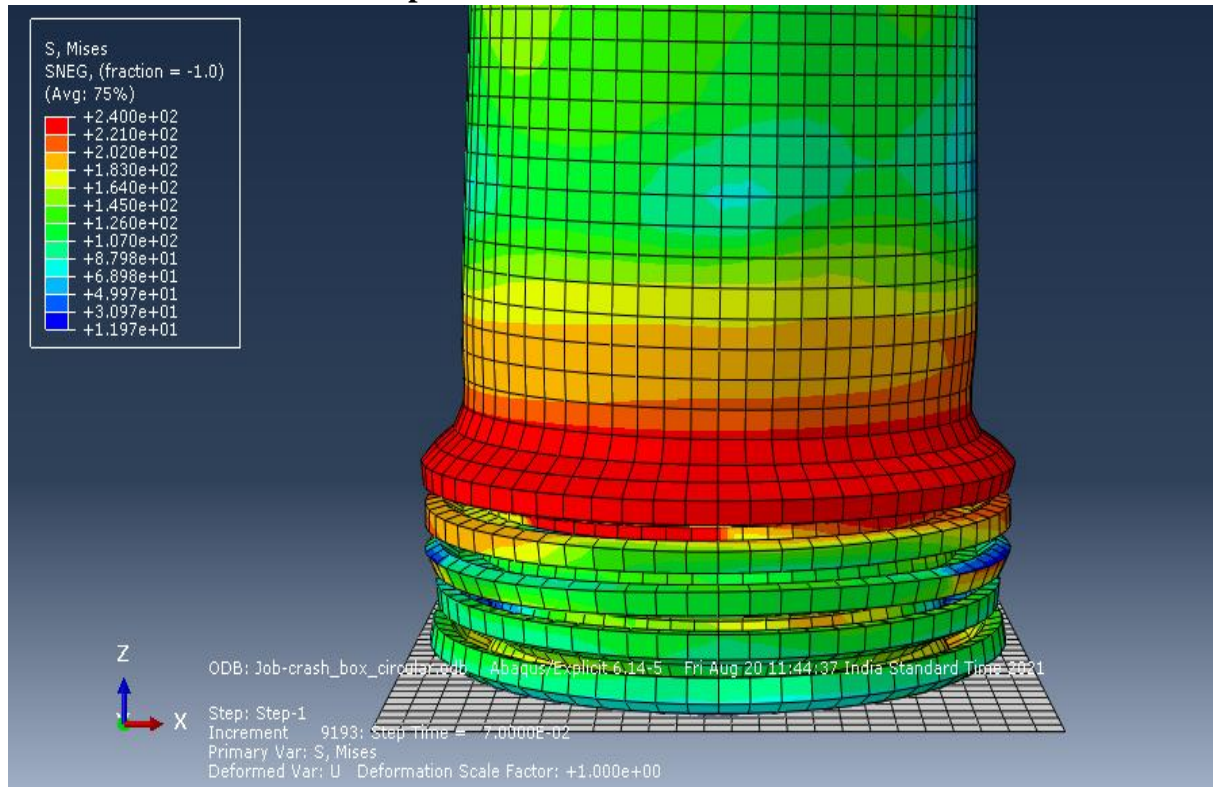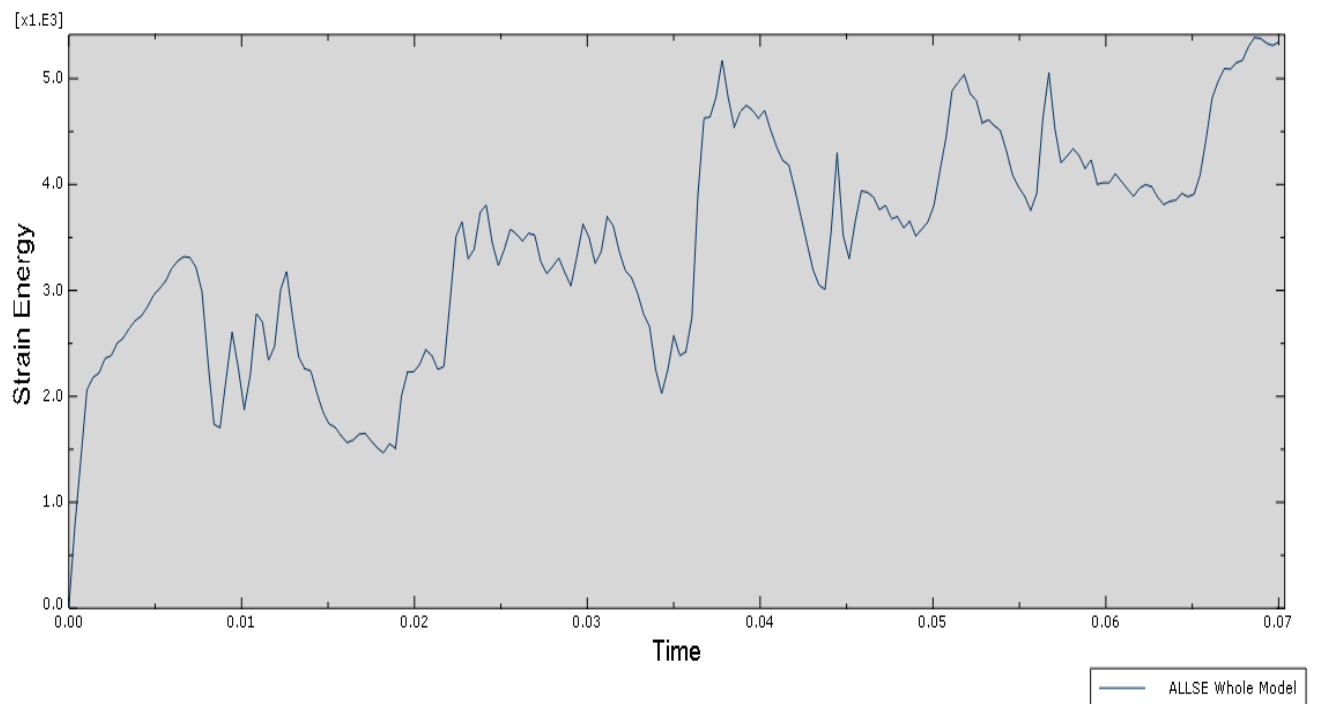### Circular crash box Isometric view:

Circular Crash box deformation representation:
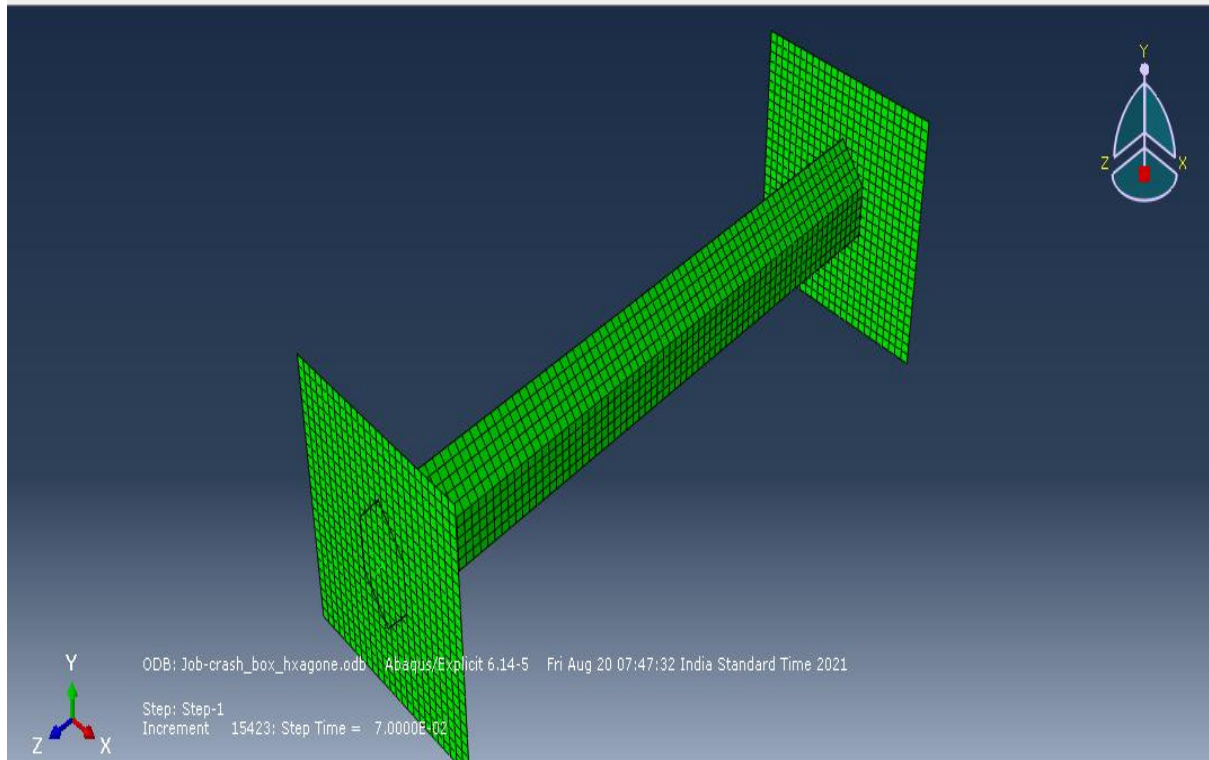
Circular Crash box Stress representation:

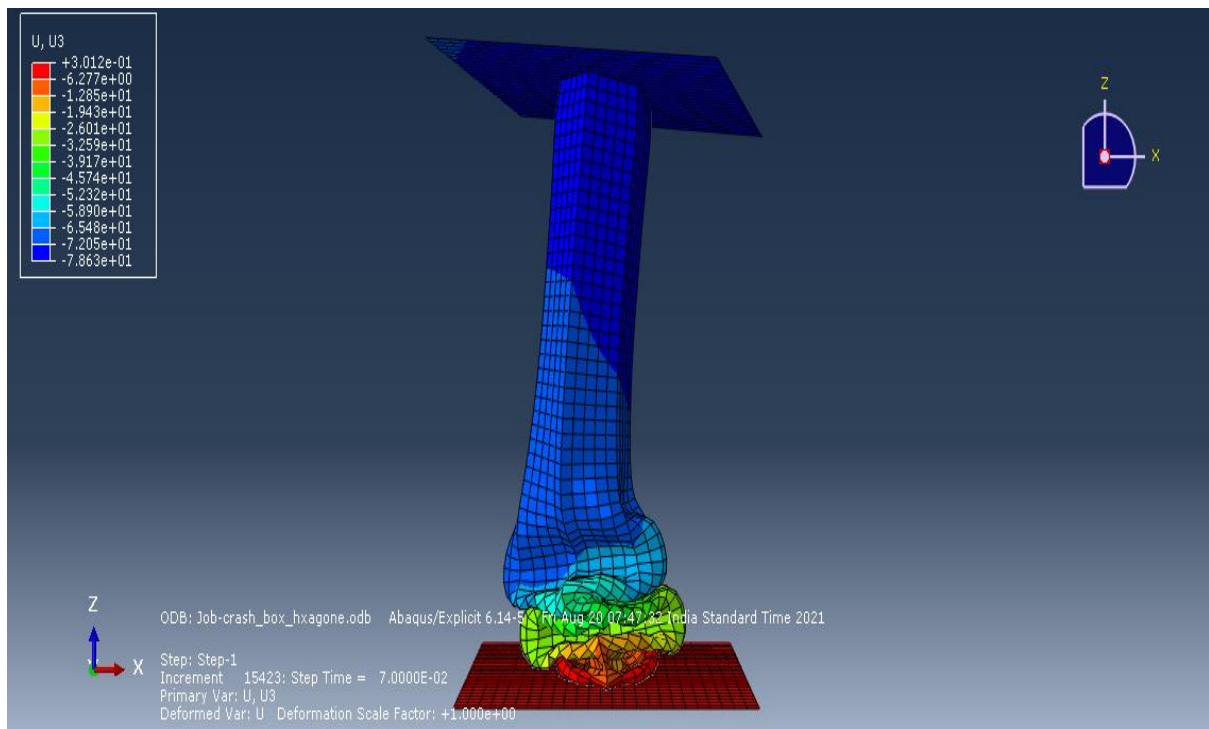## Strain Energy vs time representation during deformation:
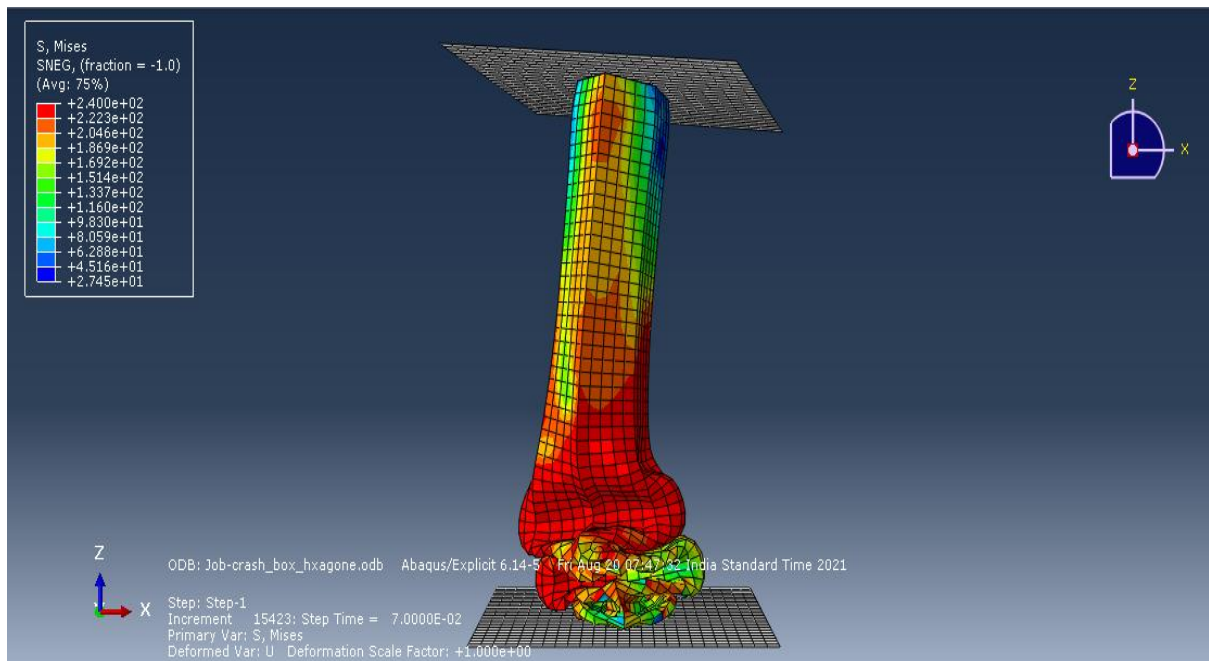
4. Hexagonal crash box analysis:
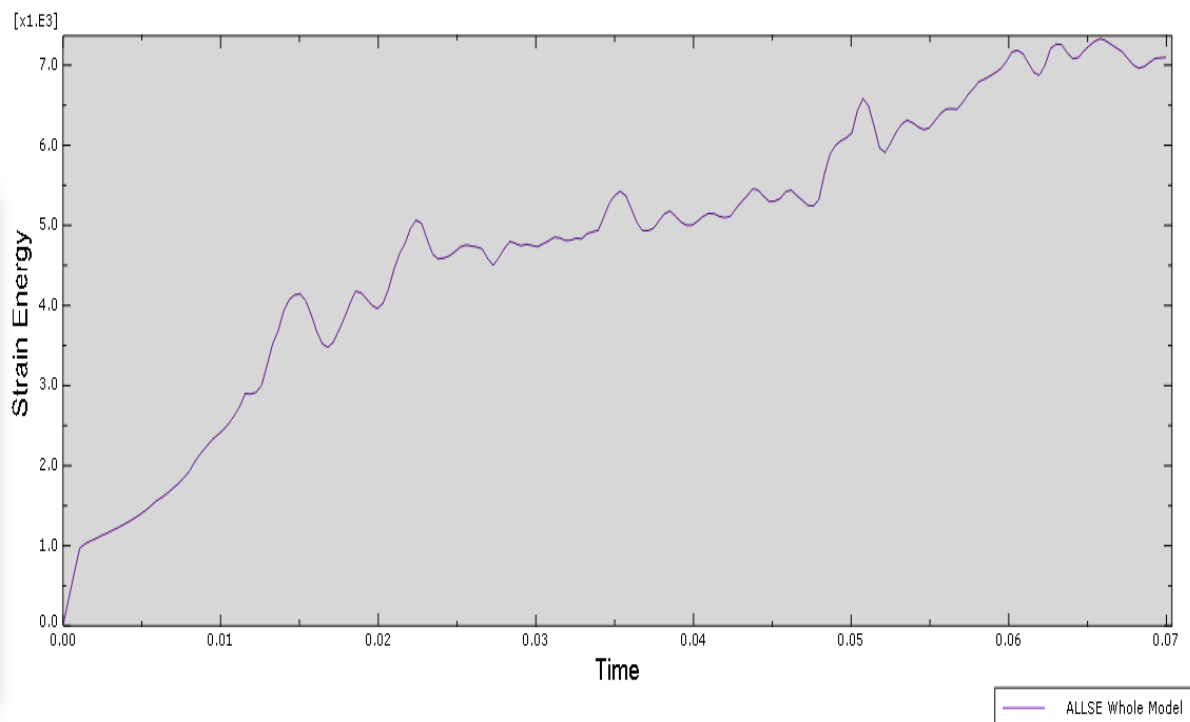
Side=10mm

Hexagonal crash box isometric view:

Hexagonal Crash box deformation representation：

Hexagonal Crash box Stress representation:

Strain Energy vs time representation during deformation:

5. Octagonal crash box analysis:

Side=10mm

Octagonal crash box isometric view:

Octagonal Crash box deformation representation：

Octagonal Crash box Stress representation:

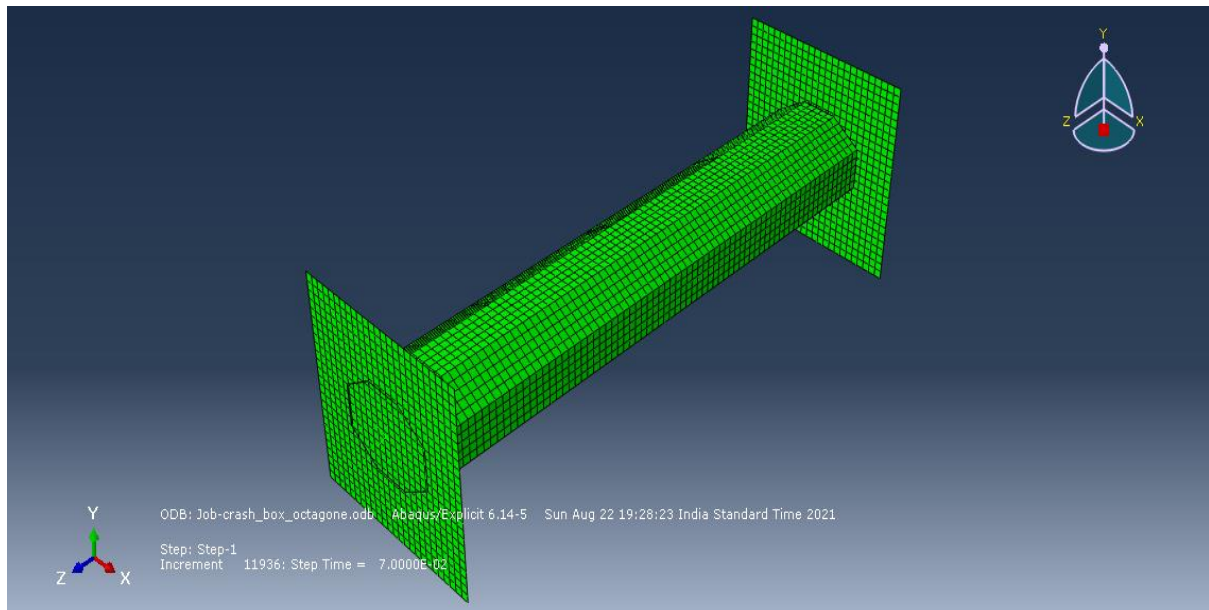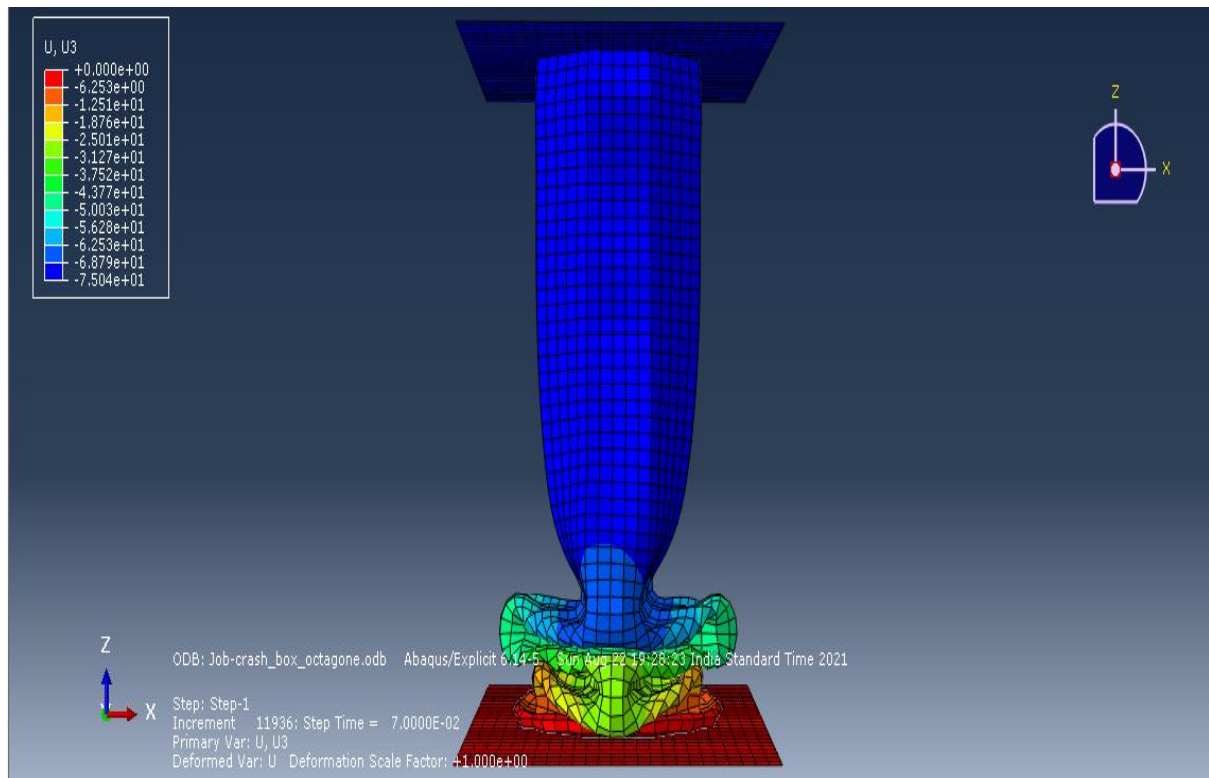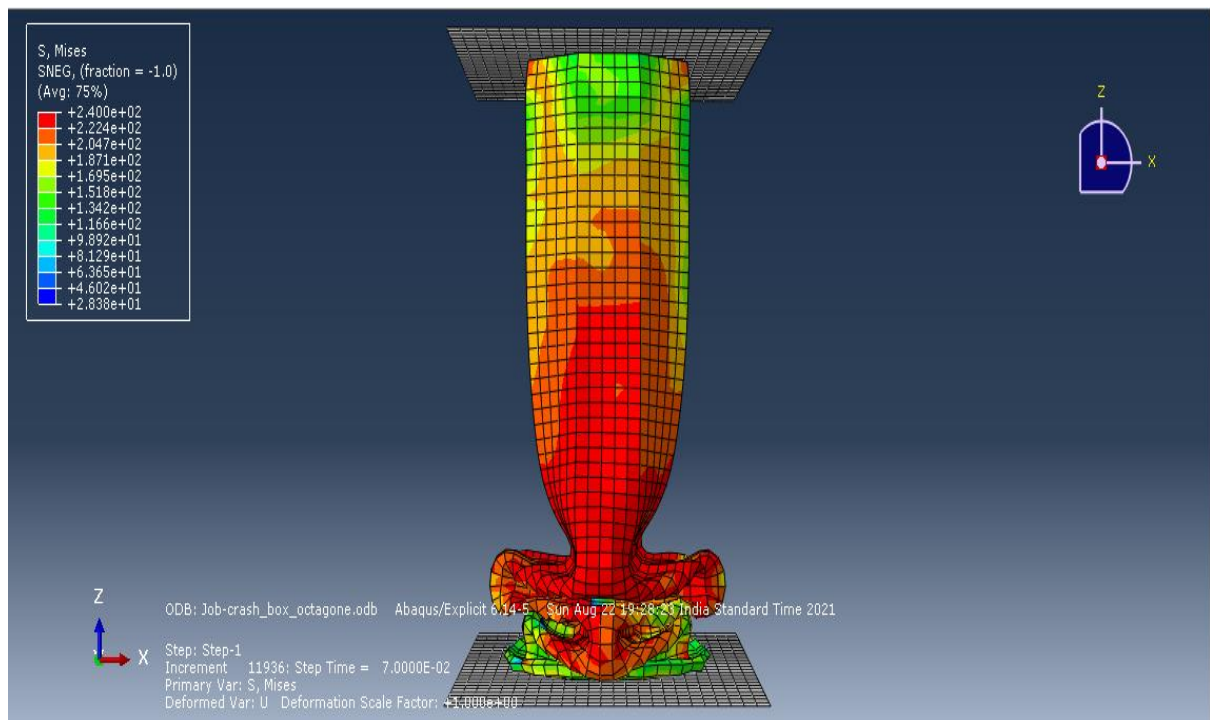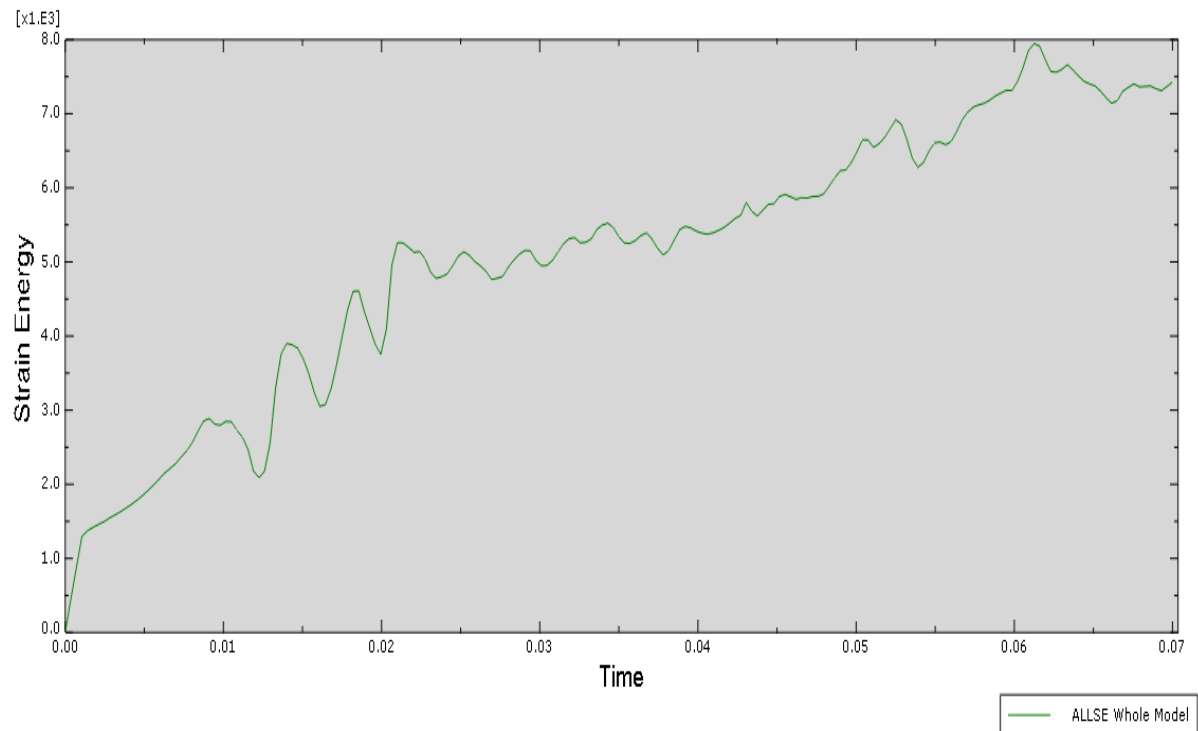## Strain Energy vs time representation during deformation:

Comparison Table				
S.No.	Name	Deformation	Max. Stress induced	Max. strain energy
1	Square crash box	75mm	240Mpa	17500 J
2	Rectangular Crash box	75mm	240Mpa	8900 J
3	Circular Crash box	75mm	240Ma	5500 J
4	Hexagonal crash box	75mm	240Mpa	7500 J
5	Octagonal crash box	75mm	240Mpa	7900 J

Conclusion

Square crash box absorbed the highest amount of energy and hexagonal crash box absorbed the least energy. So for this particular material ,dimensions and load square crash box is best suitable.

References:

- Internet sources
- Udemy course by Veer tutorial on abaquas.