Computational Simulation of Cylindrical Pressure Loading

MEG 795 Special Topics: Energy Methods II

Presented By:
Nallani Gopi

Nov 20 , 2003

Department of Mechanical Engineering
University of Nevada,Las Vegas

Objectives

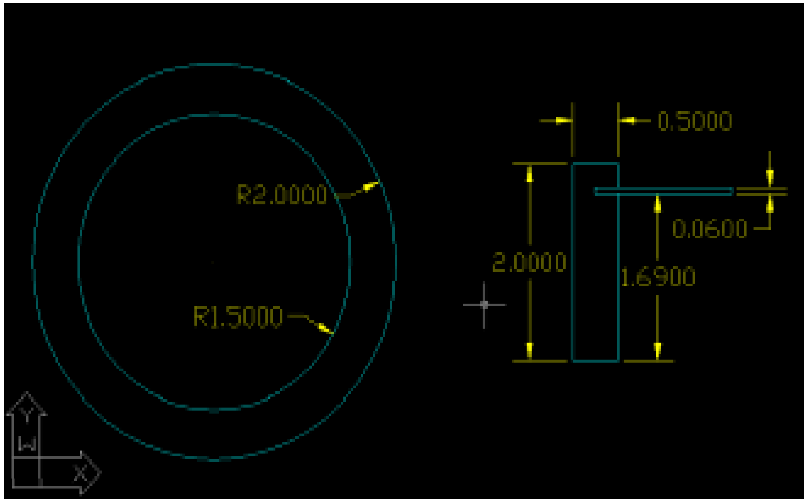
- The main objective of the design is to mitigate the incident shock loading.
- To reduce the stress waves transmitted to the electronic circuit board.
- To find the suitable shock absorbing material.

Modifications

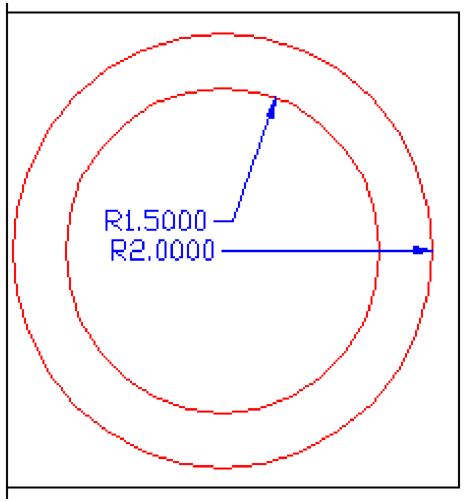
- The nodes on the circuit board and elastomeric material are divided into equal number of parts i.e., 4 parts.
- The load curve supplied by the army people is for the 6in cylinder, but here we are using a 4in cylinder. So we have reduced the pressure by a factor of 2.25(divided the pressure value by 2.25).

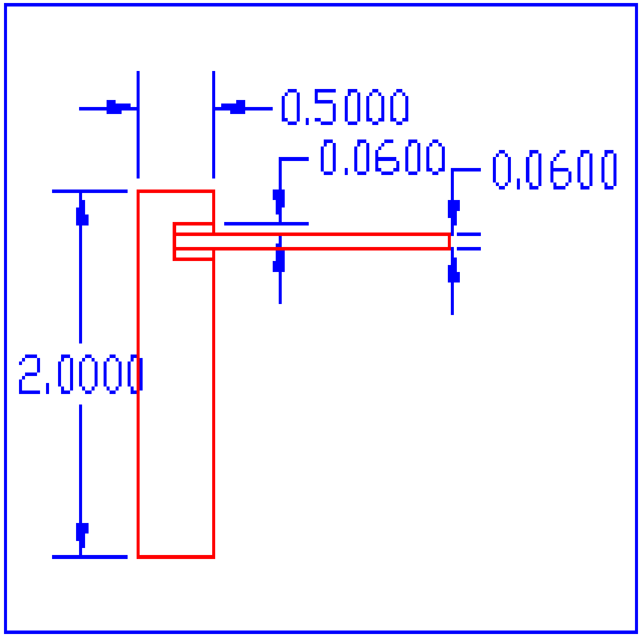
Modeling

- The model consists of a hollow cylinder with the outer radius of 2 in and inner radius of 1.5 in.
- The height of the cylinder is 2 in.
- The circuit board and elastomer is hooded into half the thickness (0.25in) of the cylinder.
- The circuit board and elastomer is 0.06in thick.
- The cylinder is made up of Aluminum alloy TA 7075 T6,circuit board of Fiber Glass and shock absorbing of elastomer.



Modeling (Contd...)

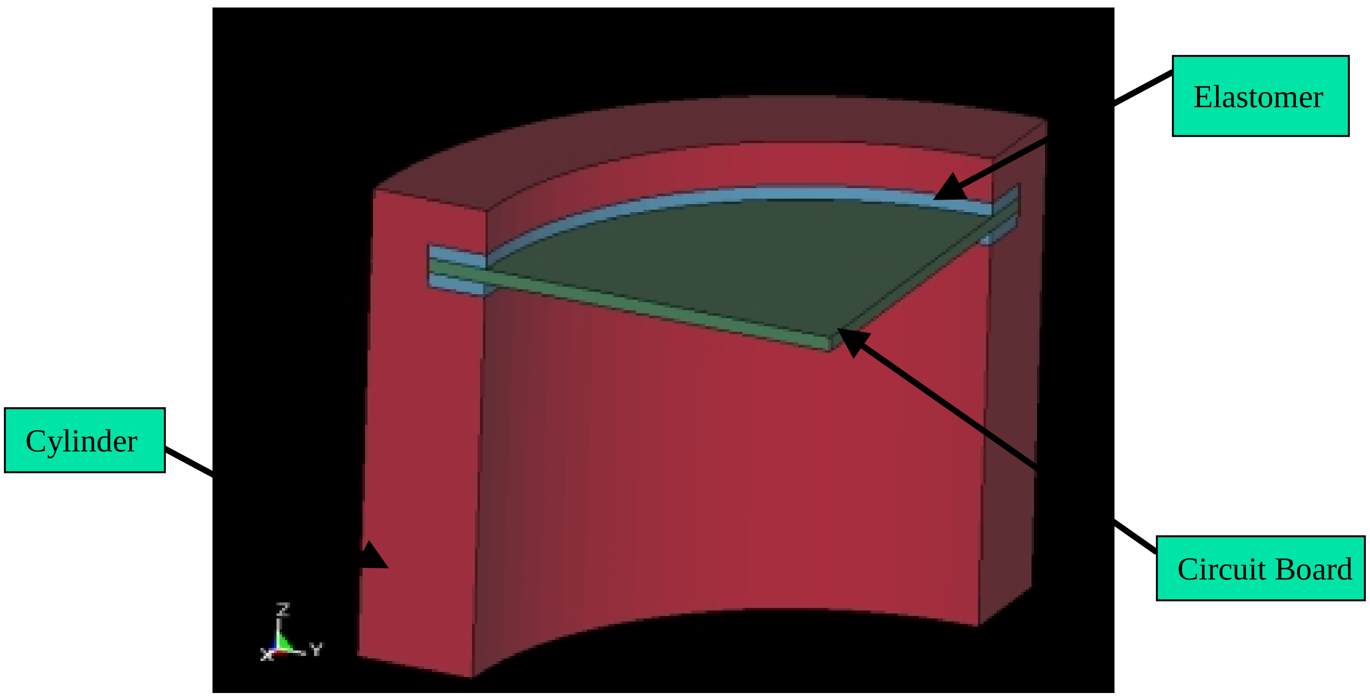




Geometry

- This model is constructed using the Ansys
- The key points are created and then the lines are joined using the points.
- Joining the lines arbitrary creates area and the areas are swept along the Z-axis.
- Here the quarter model is considered.

Ansys Model

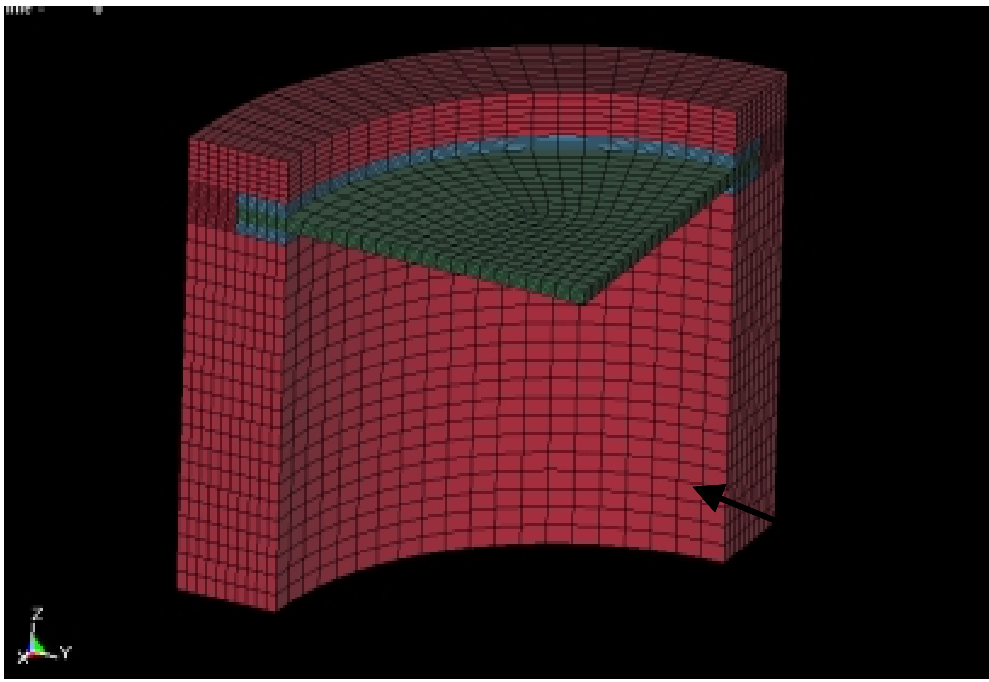


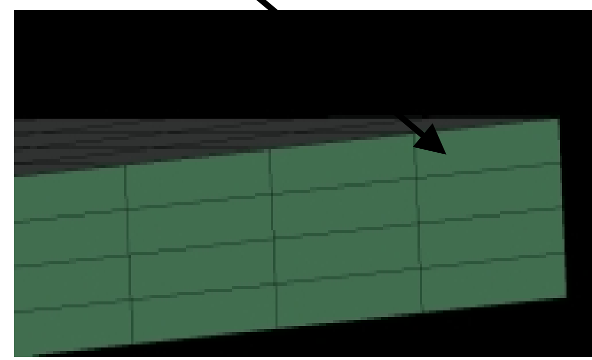
Meshing Model

- The meshed model contains solid elements.
- Integration points of 20 parts are considered for the radius of the cylinder,10 parts for the thickness of the cylinder and 3 parts for the thickness of the plate.
- Hexagonal mapped brick elements are used to mesh this model.

Meshing Technique

Circuit Board divided in to 4 equal number of parts through the thickness direction





Brick element mesh

The model showing meshing of solid elements

Material properties

Element Type	Material Model	Material Properties
Solid 164	Plastic Kinematic	Density = 0.102 lb/in^3 Young's Modulus = 10400 Ksi Poisson's Ratio = 0.33 Yield Stress = 7320 Ksi
Solid 164	Orthotropic	Density = 0.00318 lb/in^3 E_X = 2.86 Ksi E_Y = 2.86 Ksi E_Z = 1.32 Ksi NUXY = 0.14 NUYZ = 0.18 NUXZ = 0.18 GXY = 0.537 Ksi GYZ = 0.421 Ksi GXZ = 0.421 Ksi
Solid 164	Linear Isotropic	Density = 0.0144 lb/in^3 Young's Modulus = 1066.7 Ksi Poisson's Ratio = 0.33

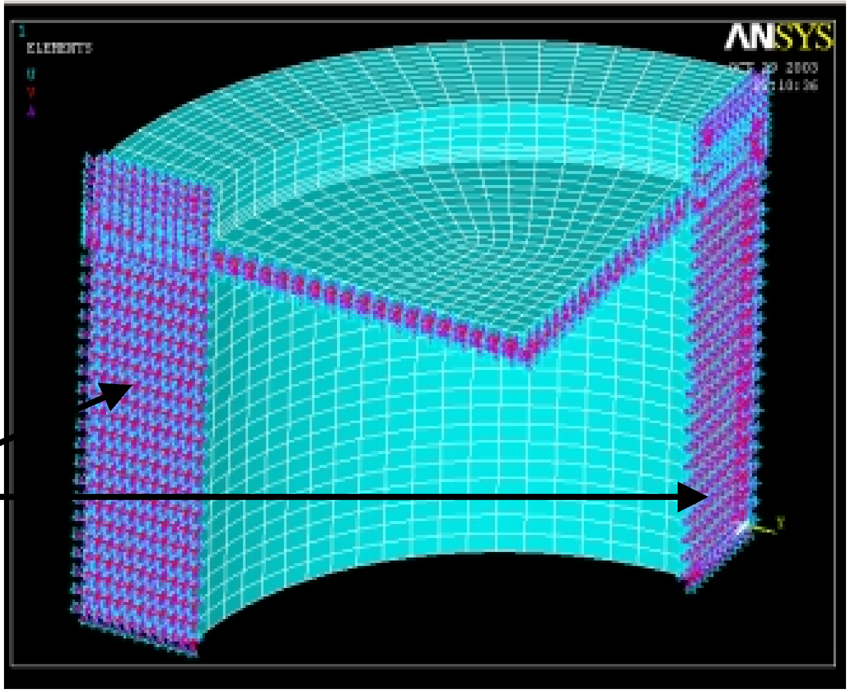
Contact Algorithms

- Generally we need to define contact for the parts.
- In this case, we do not need the contacts to be defined because the nodes of the cylinder exactly merge with the nodes of the plate.

Boundary Conditions

- As far as this model is considered, there are no restricted boundary conditions that can be applied.
- Because we are using the quarter model in our problem therefore we need to constrain the faces in the Planes of Symmetry.
- The faces in the X-direction are constrained in UY, ROTX, ROTZ.
- the faces in the Y-direction are constrained in the UX, ROTY, ROTZ respectively.

Boundary Conditions (Contd…)



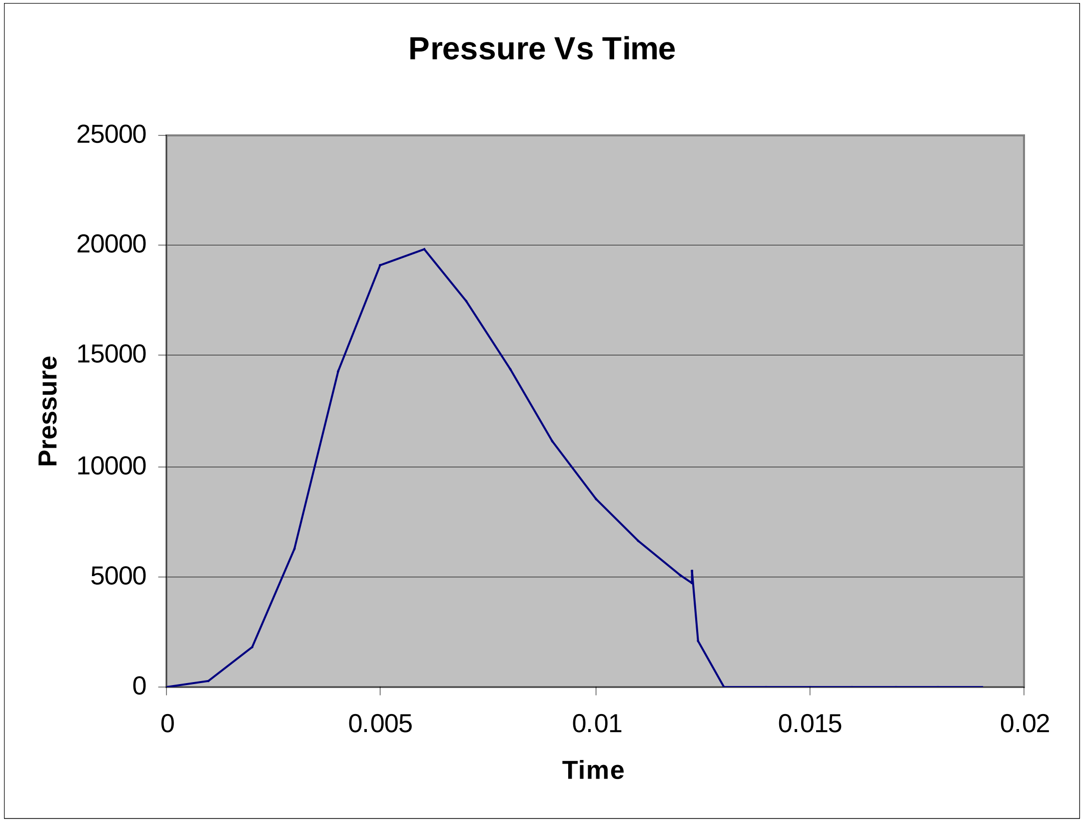
Planes of symmetry

Boundary conditions on the planes of symmetry

Control cards

- In order to apply the pressure,the LOAD_SEGMENT control card is used.
- The Load is applied through the Pressure - Time curve.
- The curve is defined through the DEFINE_CURVE control card.

Load Curve



Pressure Vs Time
Pressure
25000
20000
15000
10000
5000
0
0
0.005
0.01
0.015
0.02
Time

Control cards (Contd…)

***DEFINE_CURVE**

$	LCID	SIDR	SFA	SFO
	3	0	1	1

LCID - Load Curve ID

SIDR – Equal to 0: Load curve used in transient analysis

SFA – Scale factor for abscissa value

SFO – Scale factor for ordinate value

Control cards (Contd…)

- The pressure is applied at the bottom of the cylinder in the positive Z-direction.
- ***LOAD_SEGMENT**

$	LCID	SF	AT	N1	N2	N3	N4
	3	1	0	4644	5024	5023	4643

LCID - Load curve ID, here it is 3

SF - Load curve scale factor, we have taken 1

AT - Arrival time for pressure or birth time of pressure

N1 - Node Number

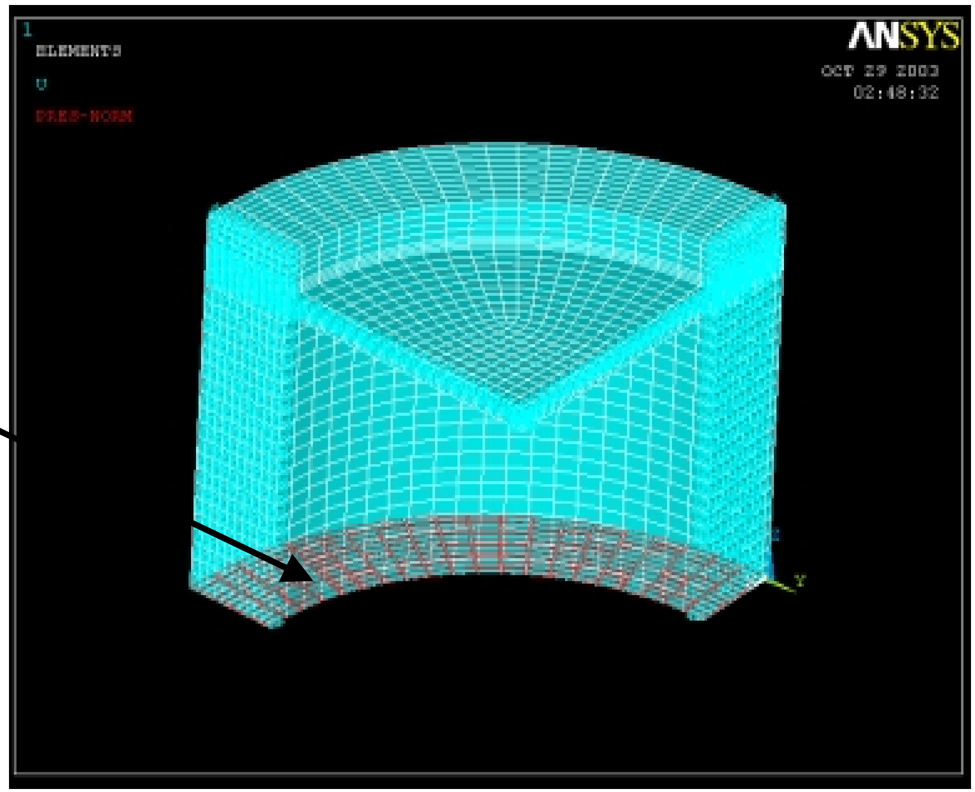
N2 - Node Number

N3 - Node Number

N4 - Node Number

Pressure Loading

Applied Pressure along the positive Z-direction

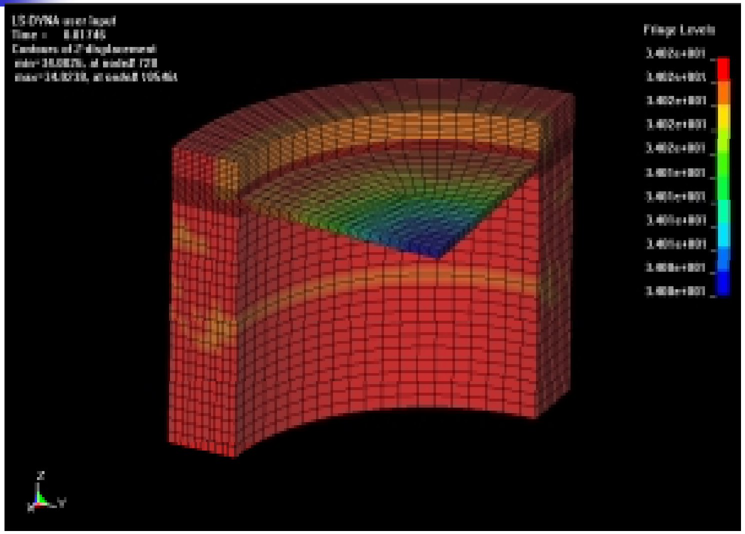


Pressure is applied along the bottom of the cylinder in the positive Z-direction

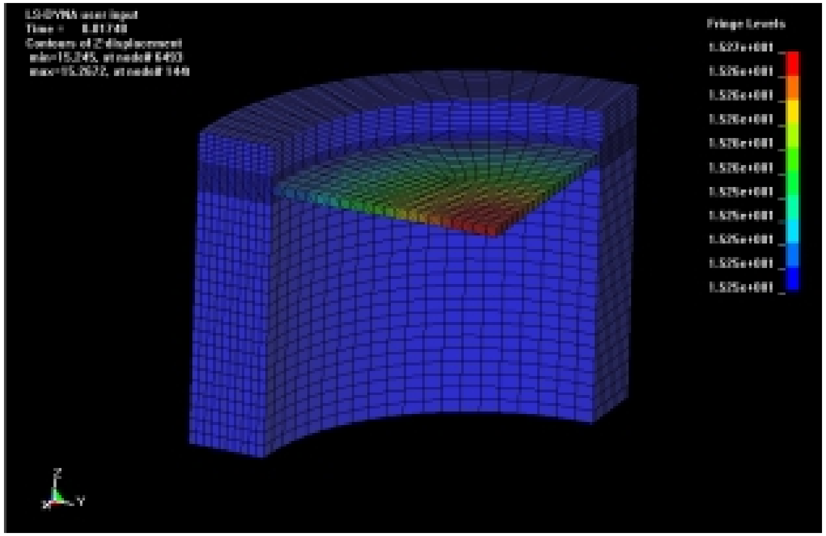
Results

- we are able to determine the stresses on the plate and how the plate behaves when the load is applied.
- By implementing the elastomeric material between the cylinder and the circuit board, we are able to decrease the shock on the plate
- The displacement, pressure and stress waves are shown for different time intervals.

Z-Displacement

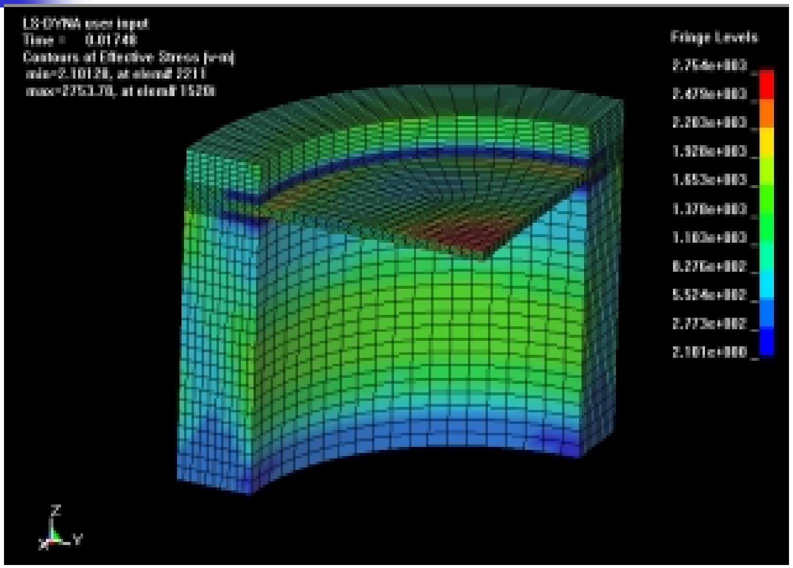


Cylinder without elastomer

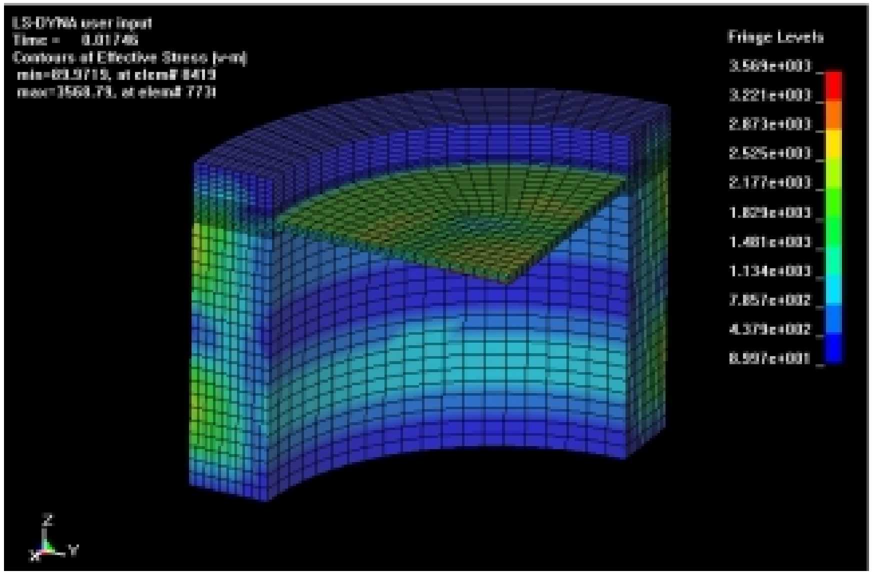


Cylinder with elastomer

Von-Mises Stress

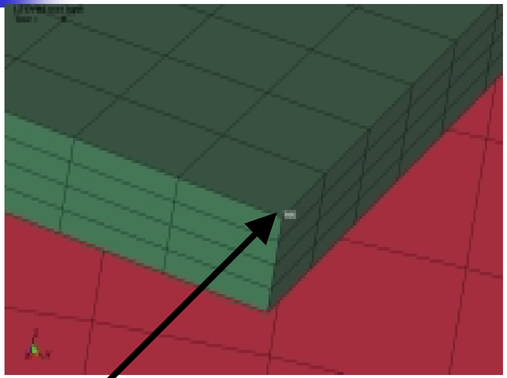


Cylinder without elastomer

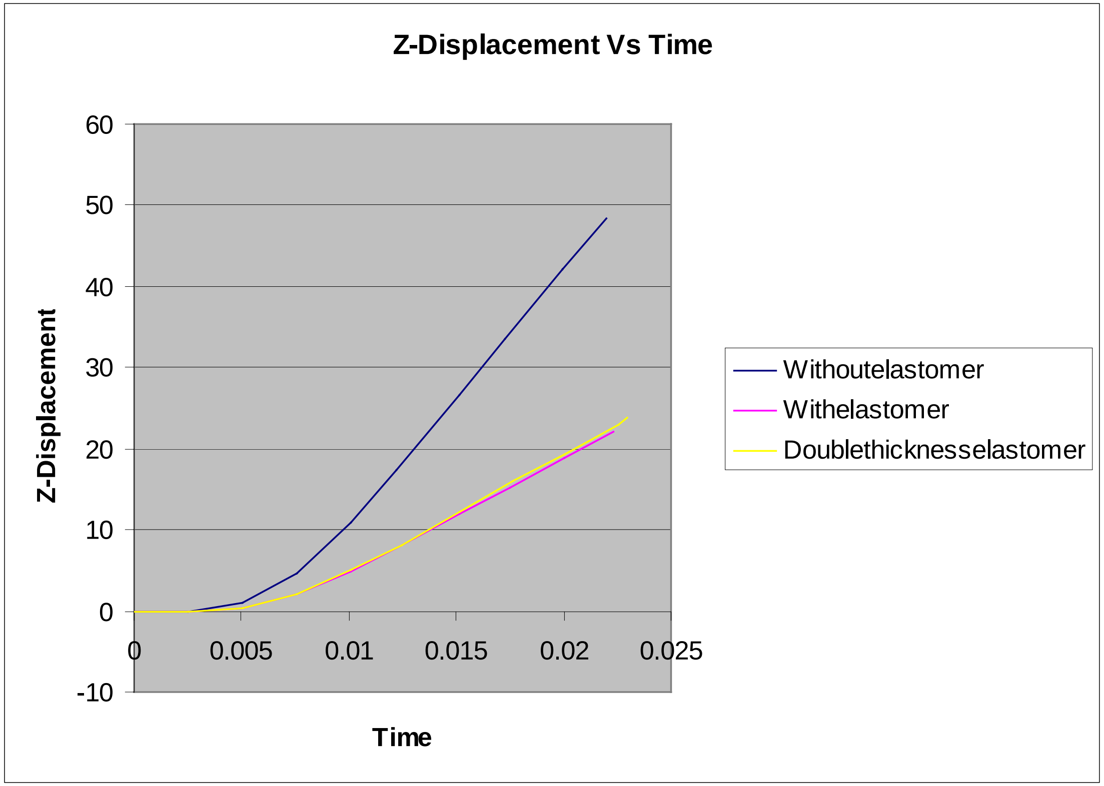


Cylinder with elastomer

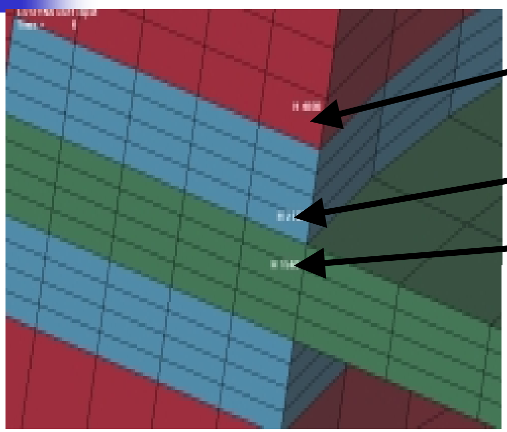
Displacement Vs Time



Displacement Vs Time curve is plotted at this node



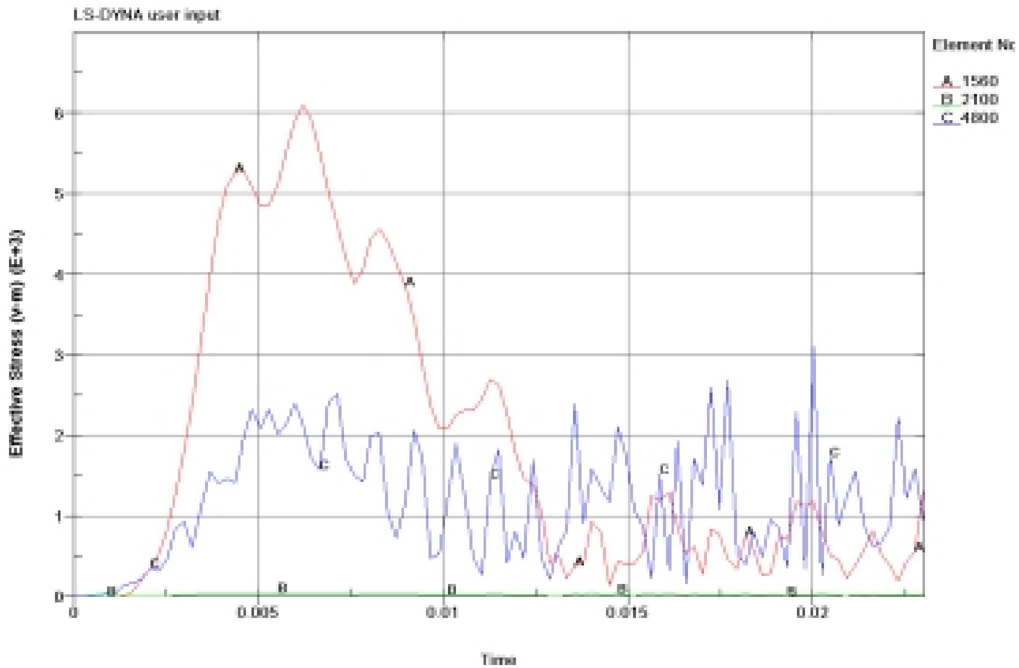
Stress Vs Time



Element (4800) on the cylinder

Element (2100) on the elastomeric material

Element (1560) on the plate



Conclusions

- The plate gets deformed when the pressure is applied on the cylinder.
- The stress waves are transmitted to the plate from the cylinder.
- The propagation of stress waves are reduced with the use of the elastomer than without using it.