Computational Simulation Of AT595 Blast Container using LS-Dyna

Presented

by

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- Long term objectives of the project

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Introduction

- This project is funded by Sandia National Laboratories,NM,USA

- Simulation of AT 595 Blast containment
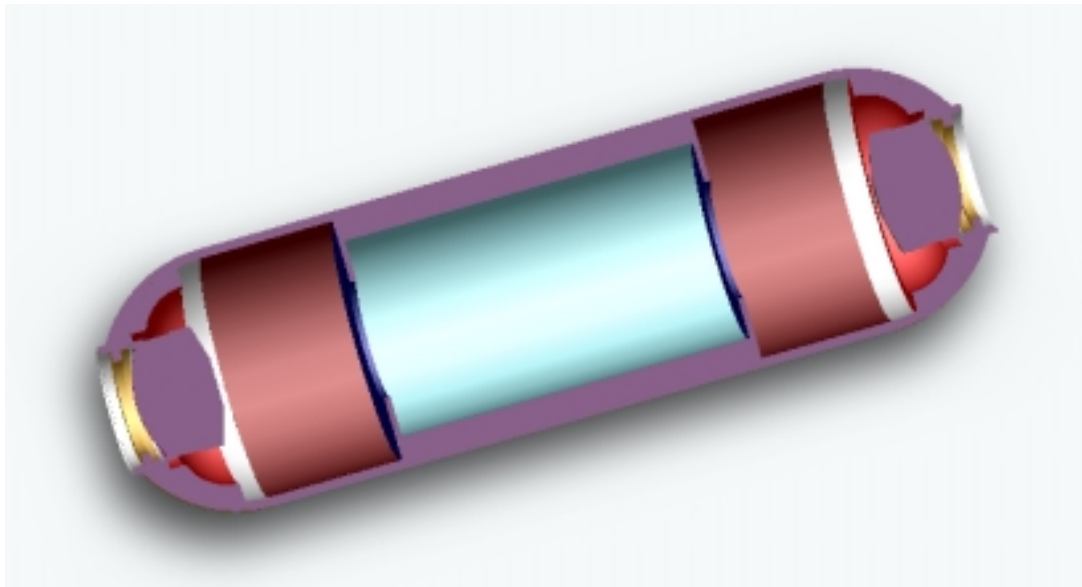
Long term objectives of the project

- Conduct computational simulations using LS/DYNA of the open cylinder experiments being conducted by the Russian Federal Nuclear Center.

- Determine the effectiveness of existing material models within LS/DYNA to predict maximum deformations and failure modes in the composite/steel structure.

- Develop a model for the full containment vessel. Compare this model with the results of the planned experiments and the Russian numerical simulations.

- Conduct parametric studies to investigate the effect of several vessel design variables on vessel performance.

Long term objectives (cont'd)

- Conduct parametric studies to investigate the effect of several vessel design variables on vessel performance.

- Optimize the vessel design to increase its strength and/or to reduce its weight.

- Investigating the various optimization parameters such as throttle plate to vessel attachment conditions,interface properties between steel and composite,gusset plate and attachments conditions.

Aim of the class project

- Modeling the containers similar to AT 595 container using shell and solid elements.

- To simulate the blast inside the containers using Conwep function

- Comparing the results of these cylinders with Russian reports

Modeling and Analysis

A. Software's used in modeling,analysis and viewing the results

B. Material properties of the various parts in the container.
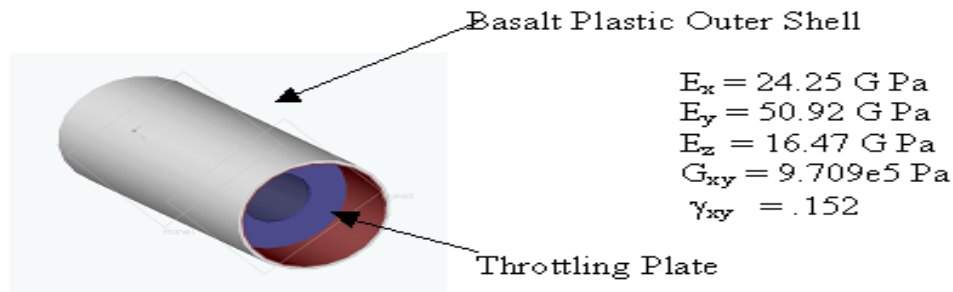
C. Current Model.

D. Boundary conditions

E. Conwep Function

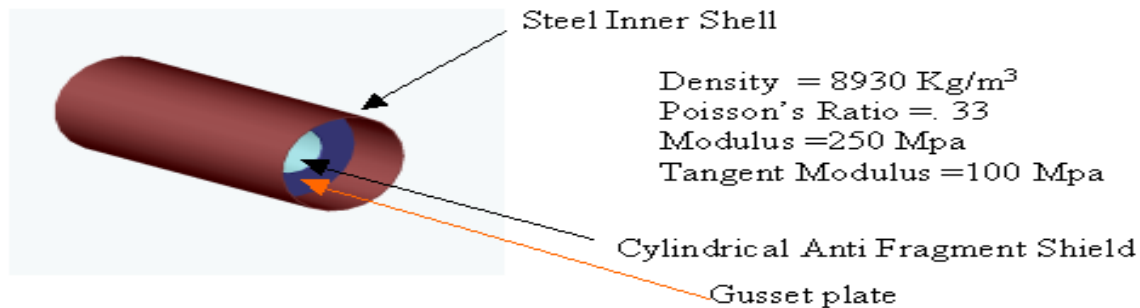# Software's used in modeling,analysis and viewing results

■ Initial cylinders were modeled using the Solidworks.

■ Later models were created in Ansys-LS Dyna due to the meshing difficulties of the imported Para-solid files in Ansys.

■ LS Dyna has been used as solver.

■ Hyper View and LS Post have been used as post processors.

Material properties of the various parts

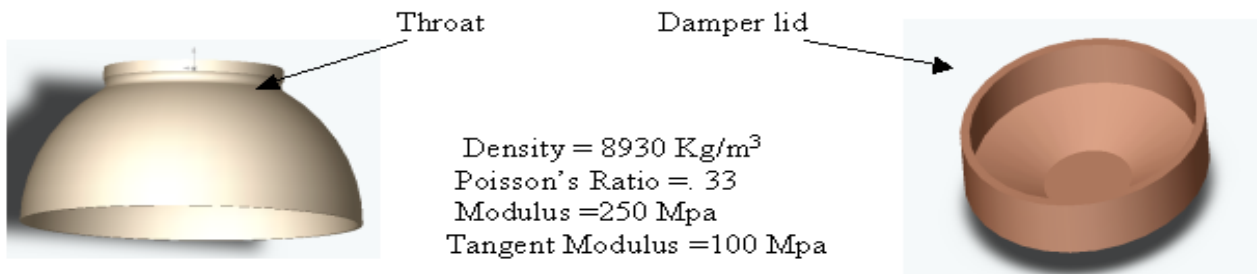Effective Material Properties of the Steel and composite shell of cylinder:

Basalt Plastic Outer Shell

$E_x = 24.25\ GPa$
$E_y = 50.92\ GPa$
$E_z = 16.47\ GPa$
$G_{xy} = 9.709e5\ Pa$
$\gamma_{xy} = .152$

Throttling Plate

Material properties of the anti fragment shield and Gusset Plate:

Steel Inner Shell

Density $= 8930\ Kg/m^3$
Poisson's Ratio $= .33$
Modulus $= 250\ Mpa$
Tangent Modulus $= 100\ Mpa$

Cylindrical Anti Fragment Shield

Gusset plate

Material properties (cont'd)

Material properties of the inner components in cap:

Throat

Damper lid

Density = 8930 Kg/m^3
Poisson's Ratio =. 33
Modulus =250 Mpa
Tangent Modulus =100 Mpa

Material properties of the outer composite liner for the cap:

Outer basalt composite layer for the cap

$E_y = 50.92$ G Pa
$E_z = 16.47$ G Pa
$G_{xy} = 9.709e5$ Pa
$\gamma_{xy} = .152$
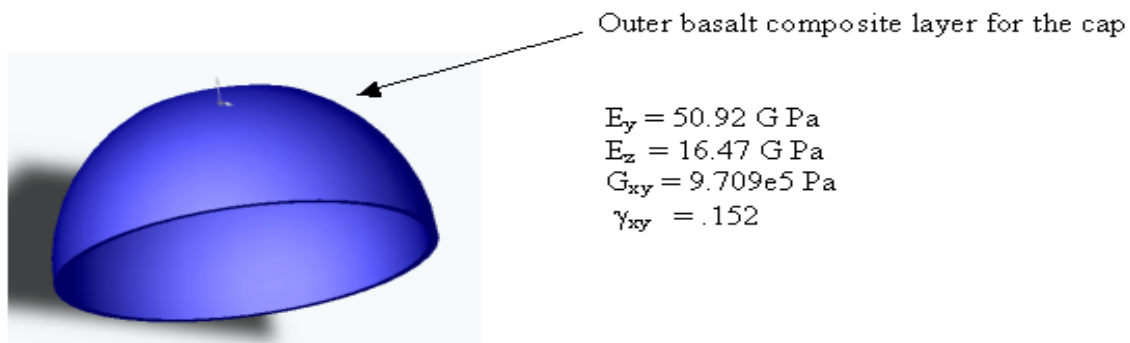
Material properties (cont'd)

Material Properties of Foam with Stress –Strain Curve:

Foam Material inside the cap

Density $= 200 \ Kg/m^3$

Modulus $= 1.076e8 \ Pa$
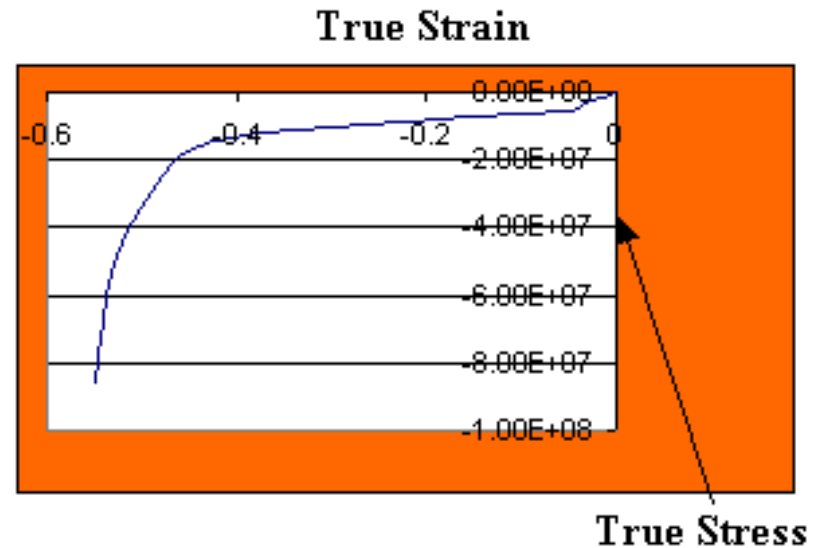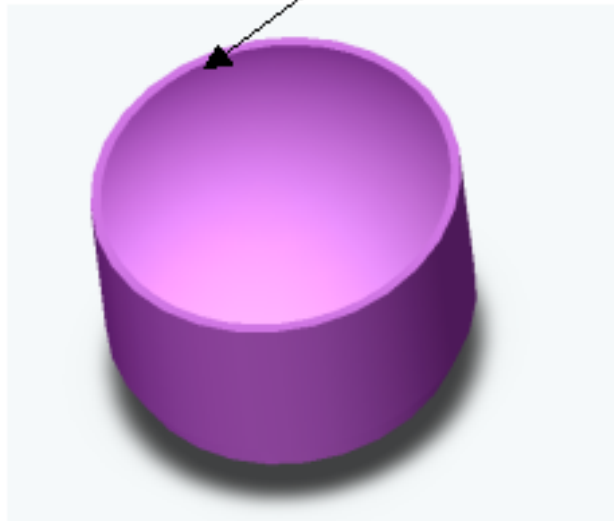
Material properties (cont'd)
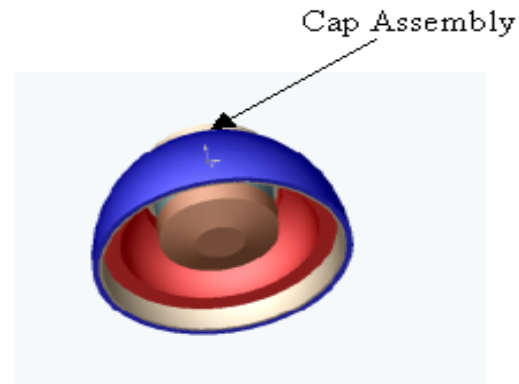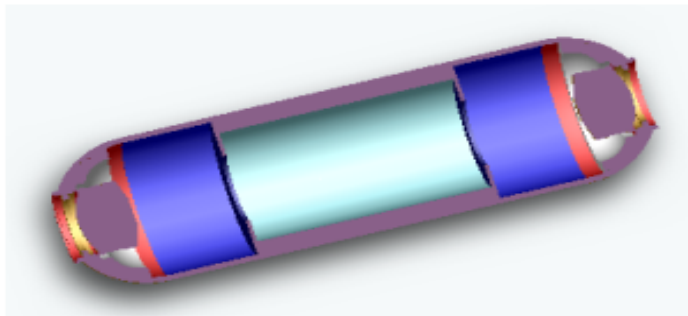
Material properties of the fragment shield:
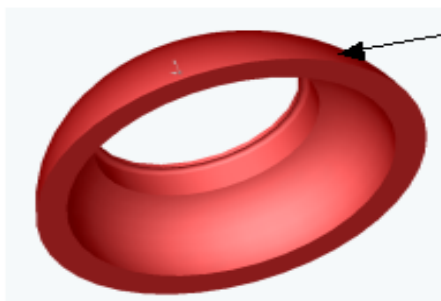
Fragment shield

Density $= 1082\ Kg/m^3$
Poisson's Ratio $= .33$
Modulus $= 10Mpa$
Yield Stress $= 5Mpa$

Fig 2.8

Total Assembly (sectioned) and cap assembly:

Cap Assembly

Current model

- Cylinder is modeled in Ansys-LS Dyna.

- This model is similar to AT 595 Explosion proof container but this model doesn't include the throttle plate and shielding material and this model has 1/8th symmetry.

- This model uses the shell element for the the cylindrical part of vessel and solid elements for the rest of the parts.

- The combined properties of the outer layer which consists of 4 layers have been calculated and induced in the shell.

- For Meshing the element size is considered to.008m on solid elements and for shell the lines have been divided into eight divisions along circumference and twenty eight along length
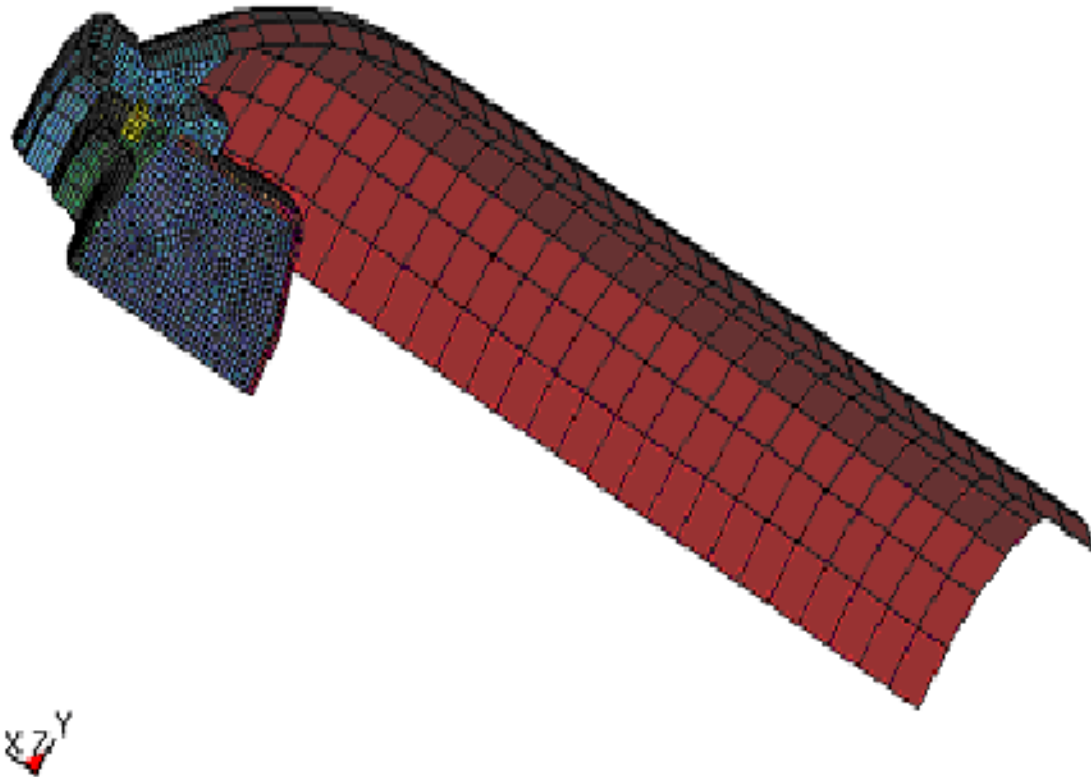
Current Model(cont'd)

- Outer shell has combined properties of 3 layers of basalt fiber of (16+8+8mm) different thickness,angles (90,33,-33 degrees) and single inner steel layer of thickness 8 mm .

- In Ansys 2-Dimensional models have been created using key points,lines and areas.

- The 2-d model has been rotated about the axis to get the 3d models.

- Meshing is done with different element and their corresponding material properties.

Current Model(cont'd)

Current Model(cont'd)
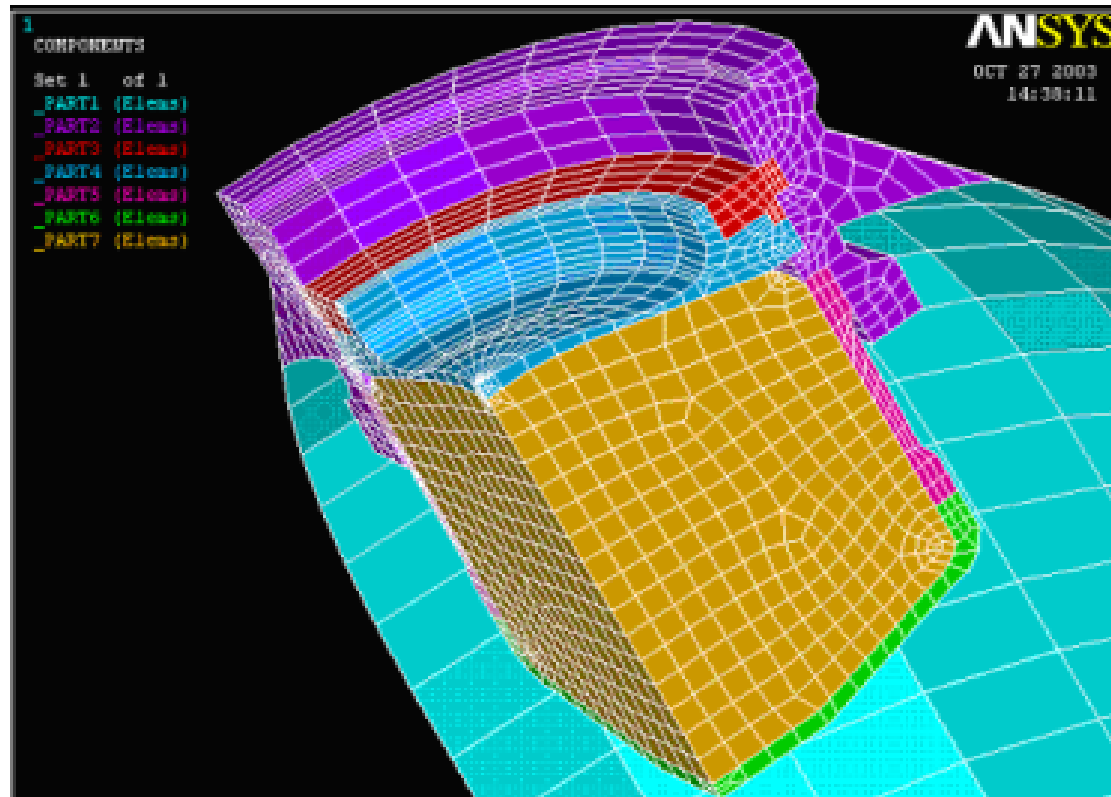
Model with meshing

Boundary conditions

| Boundary conditions for nodes in symmetry plane	Ux	Uy	Uz	Rx	Ry	Rz
X-Y Plane			0	0	0	
Y-Z Plane	0				0	0
X-Z Plane		0		0	0	

Conwep Function

- Conwep Function in LS Dyna has been used in creating the blast,which calculates the pressure at various points inside the cylinder with respect to the minimum distance from the point of the blast.

Results

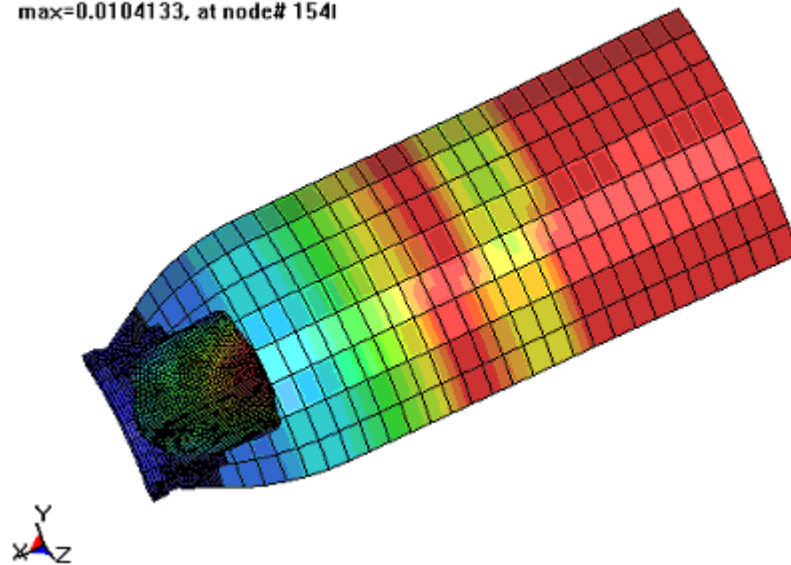- Stresses at various points inside the cylinderat at time
(t) =.6ms
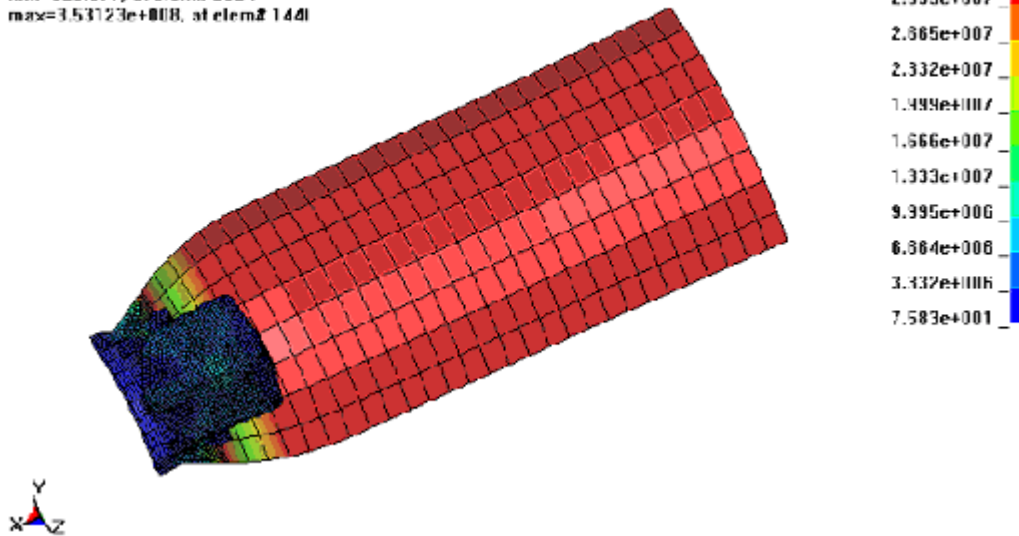
Results(cont'd)

- Displacements at various points inside the container at time(t) =.6ms

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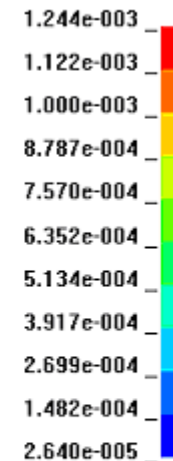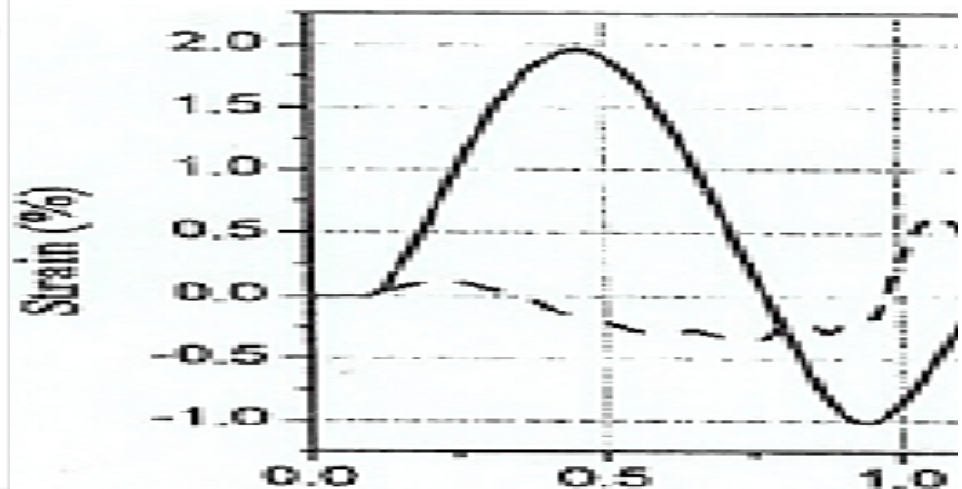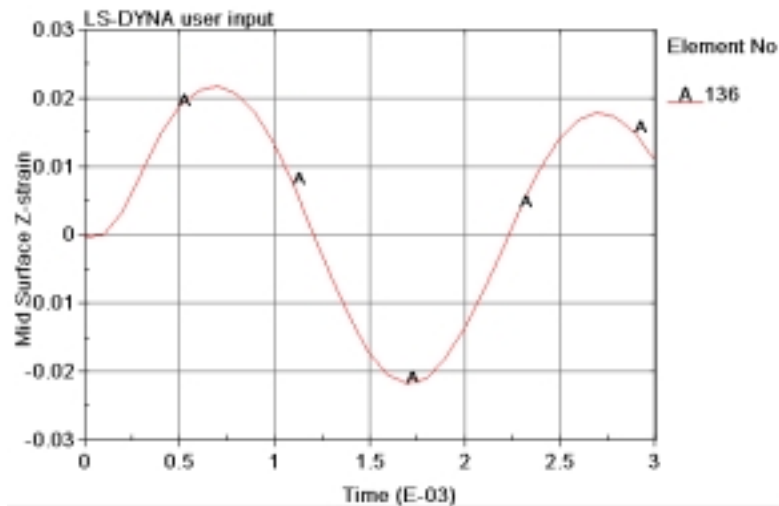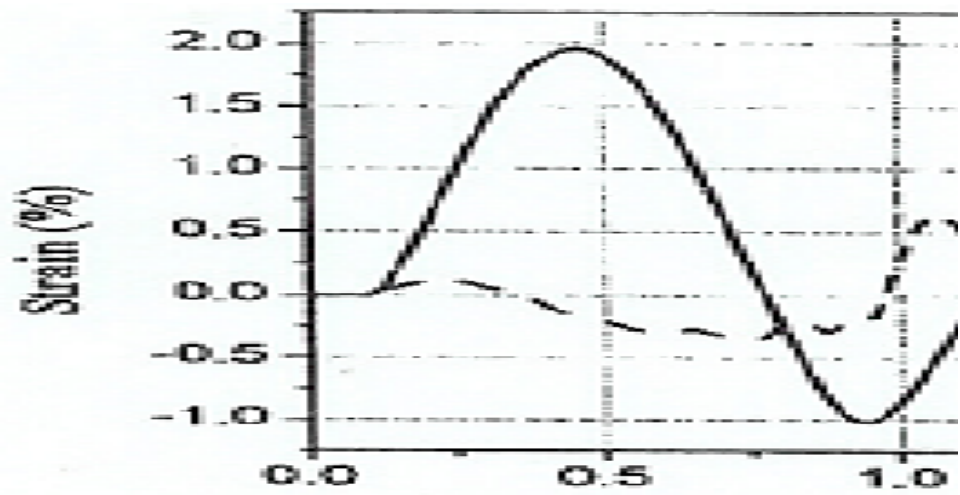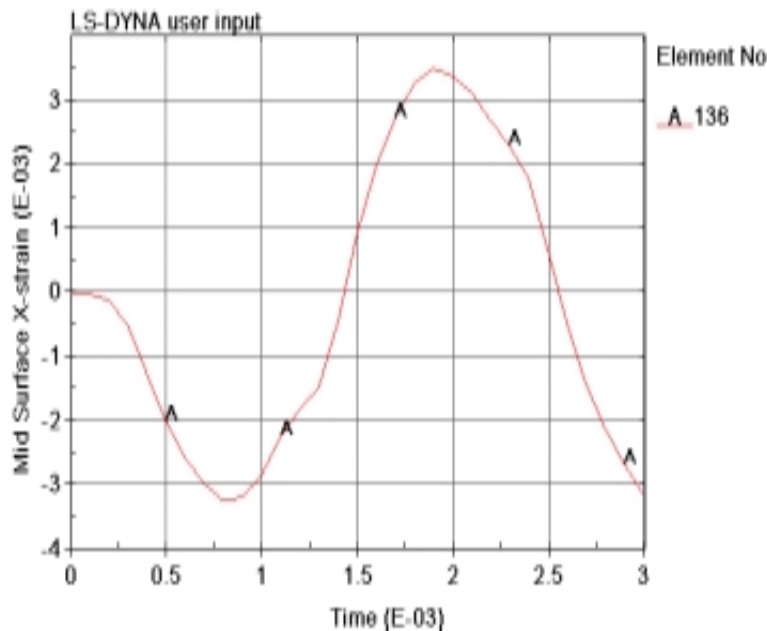
Results(cont'd)

- Plots showing the strains in the circumferential direction
- Black colored plot from the simulation and white one(black colored line) is from the report

Results(cont'd)

- Plots showing the strains in the hoop direction
- Black colored plot from the simulation and white one(dotted line) is from the report

Comparing the results of the shell model with the solid model of same dimensions(with one layer of solid after meshing and 2 layers of composite after meshing.)
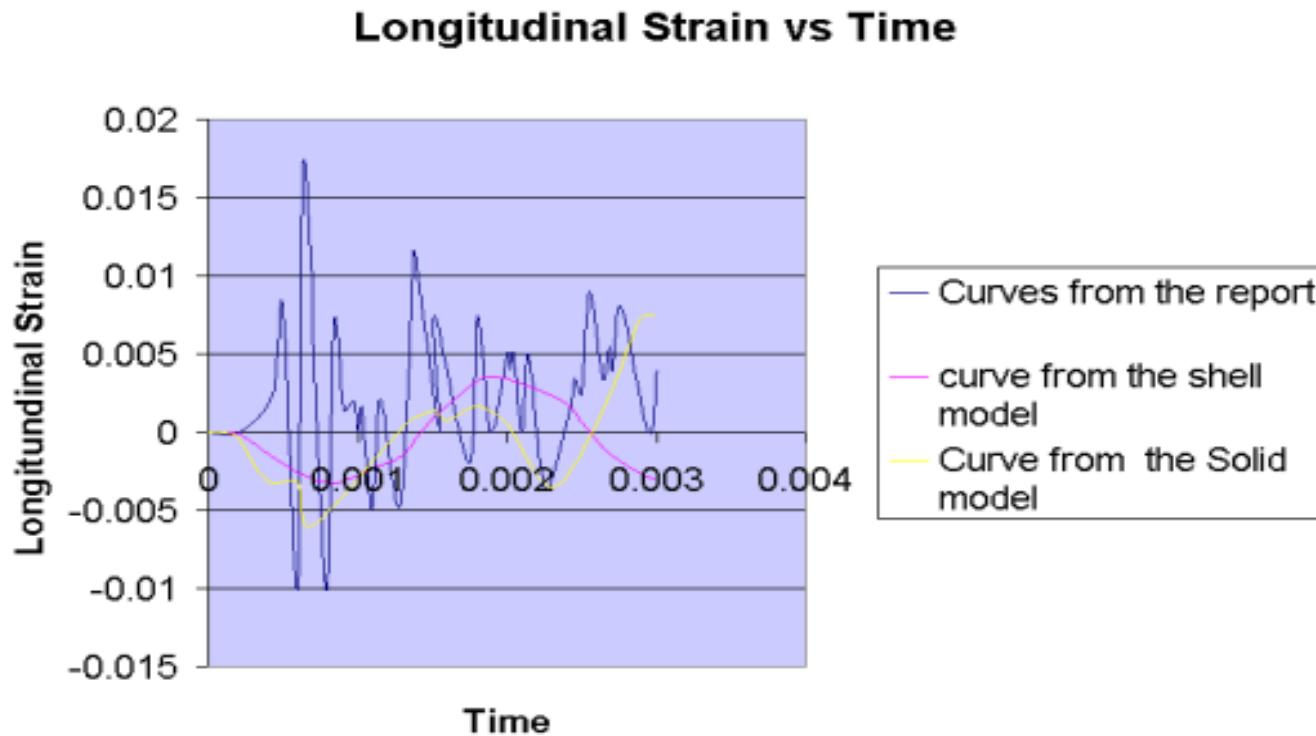
Longitudinal Strain vs Time

Fig 4.12(Comparing the strains in the Longitudinal direction)

Comparing the results with the solid model of same dimensions (which has one layer of steel after meshing and 2 layers of composite after meshing)
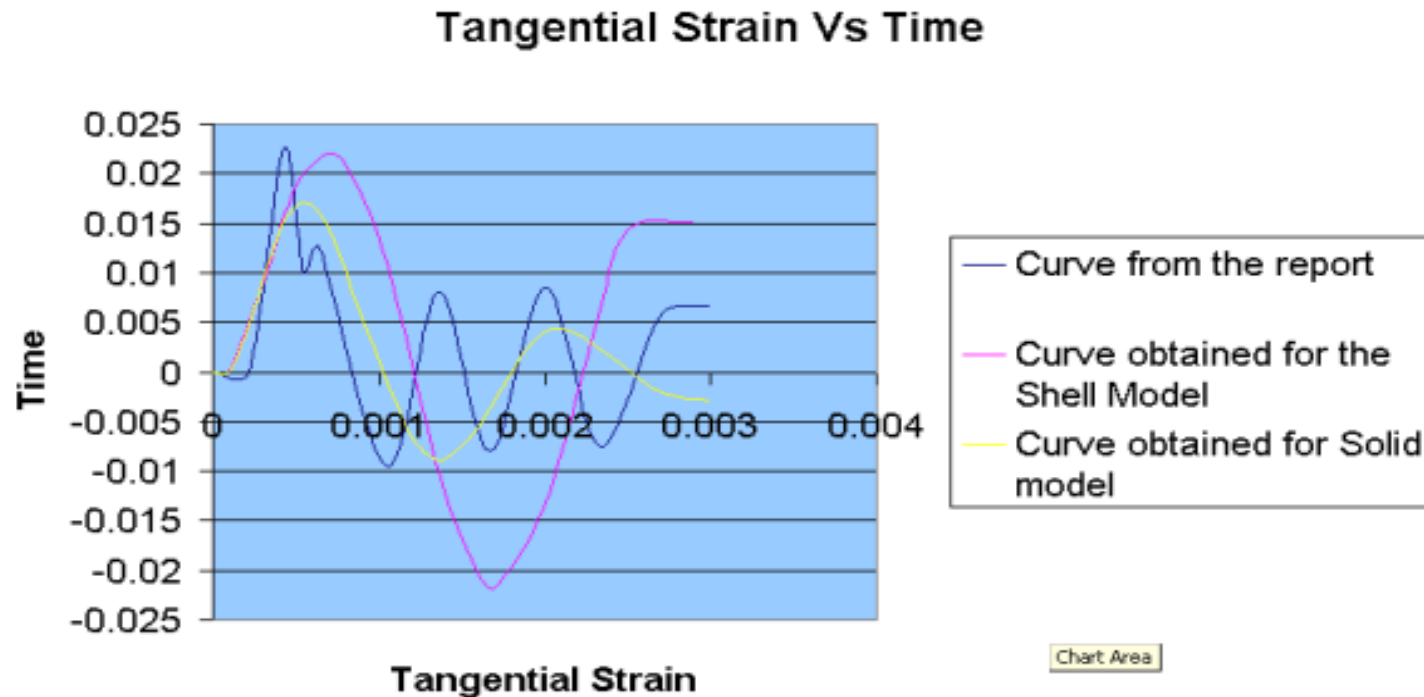
Tangential Strain Vs Time

Fig 4.13(Comparing the strains in the circumferential direction)

((Ref for both the above curves: Final report of Explosion-Proof Container contract (#AX-3828) between

the Sandia corporation (USA) and RFNC-VNIIEF (RUSSIA))

Results(cont'd)

- The Variation in the results is due to the following reasons:

- The Shielding material and throttle plate are not included in the current model.so the thickness of the original model is different from that of the created model.

- Dimensional Error : The dimensions from the Russian report have been taken in creating the container.Very few dimensions have been defined in the report and most of the dimensions were measured manually.

- The meshing needs to be improved .The number of layers in the solid are to be increased to minimum of 4.

Future Work

- Present model uses shell element for the cylindrical part.Next model will use the solid elements and the results will be compared to current model.

- Meshing needs to be improved for better results

- The Differences will be analyzed.

- A suitable element for this type of model will be suggested.

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