COMPUTATIONAL SIMULATION OF CYLINDER IMPACT ON ALUMINUM HONEYCOMB USING LS-DYNA

MEG-795: Energy methods-II

BY

KUMARSWAMY KARPANAN

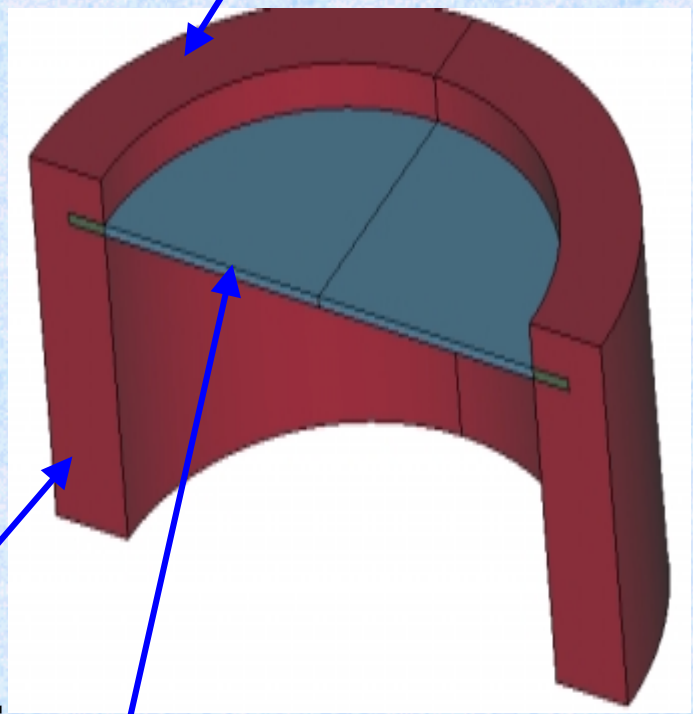
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY OF NEVADA LAS VEGAS

Projectile firing simulation

Projectile firing simulation as cylinder impact

Cylinder impact with the aluminum honeycomb



List of Symbols

Symbol	Definition	SI Units	US Units	Unit system used
ρ	Density	Kg/m3	(lb-s2)/in4	Kg/mm^3
E	Elastic Modulus	N/m^2	psi	N/mm^2
G	Shear Modulus	N/m^2	psi	N/mm^2
ν	Poisson's Ratio	-	-	
Sr	Ultimate Tensile Strength	N/m^2	psi	N/mm^2
Sy	Tensile Yield Strength	N/m^2	psi	N/mm^2
Rc	Rockwell Hardness	-	-	
t	Time	s	s	s
A	Acceleration	m/s^2	in/s^2	mm/s^2

Outline

- Objectives
- Simulation of cylinder impact
- Modeling
- Material properties
- Meshing and boundary conditions
- Results
- Future plans

Objectives

- Simulation of projectile firing by impacting the projectile's cylinder on an energy absorbing material such as, aluminum honeycomb for studying the acceleration profile of circuit board.

- Modify the material property and geometry of l honeycomb material, so that the deceleration of the projectile during the impact with honeycomb material produce specific acceleration profile as that of actual projectile firing from gun barrel.

- Conduct the cylinder impact test to verify the computational results.

Simulation of cylinder impact in LS-DYNA

Case-1

The front end of the cylinder is fixed and the initial velocity of 838.2 mm /s (33 in/s) is applied on all the nodes including the composite plate.

Case-2

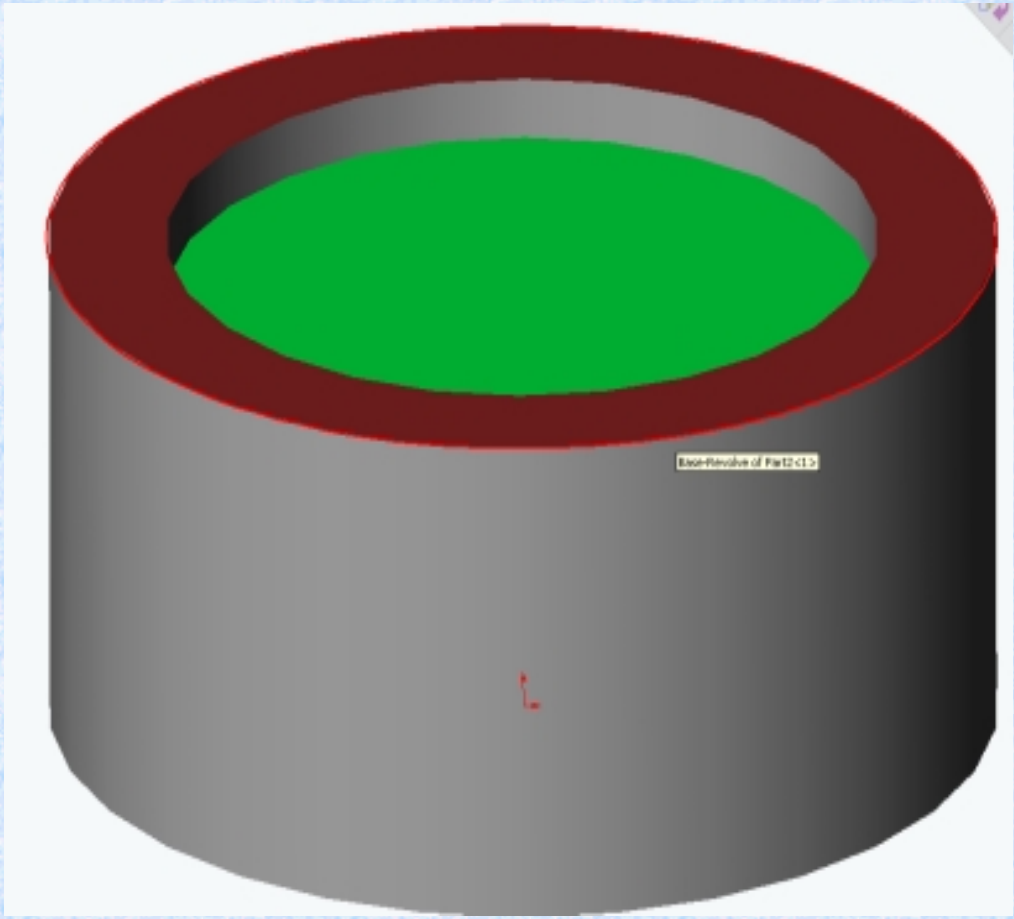
Impacting the cylinder on a rigid wall.

Case-3

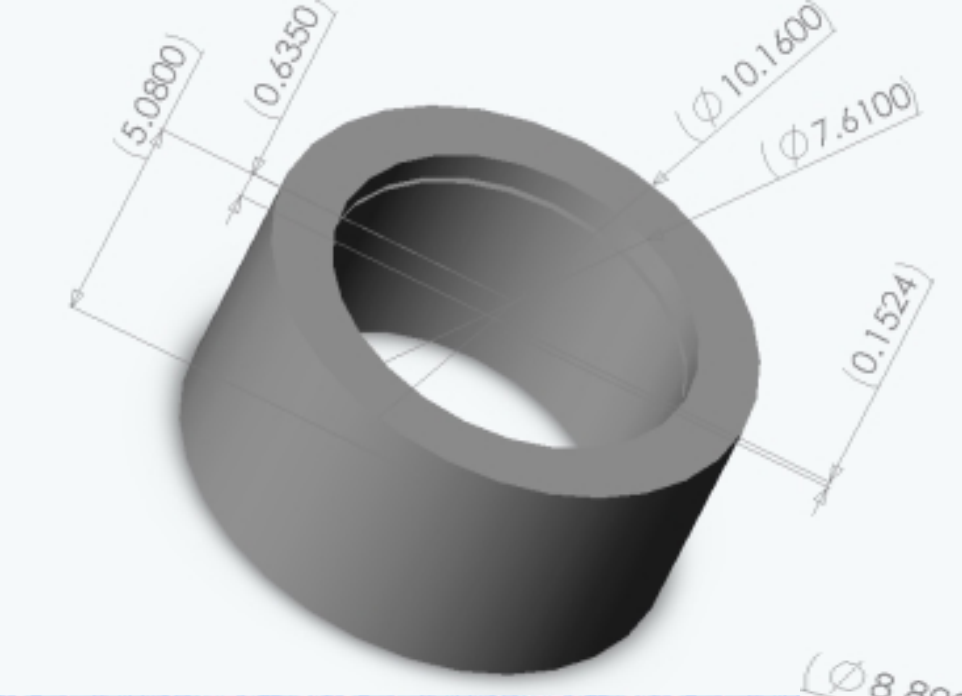
Impacting the cylinder with the solid block having aluminum honeycomb properties.

(In all the cases quarter of the model is analyzed)

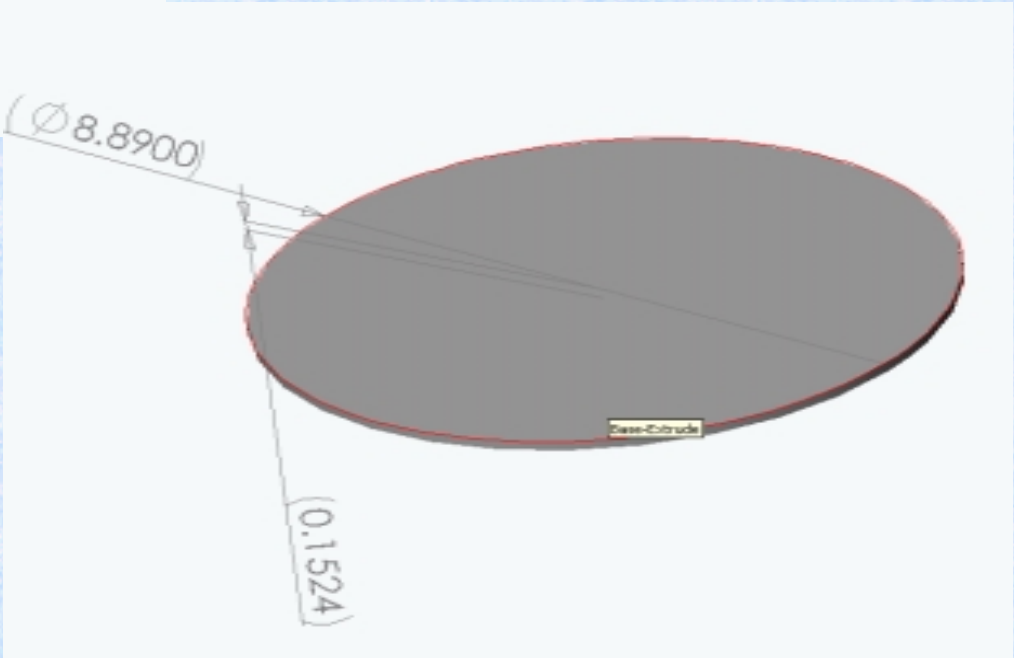
Modeling



Assembled view of cylinder



Projectile's cylinder



Composite plate

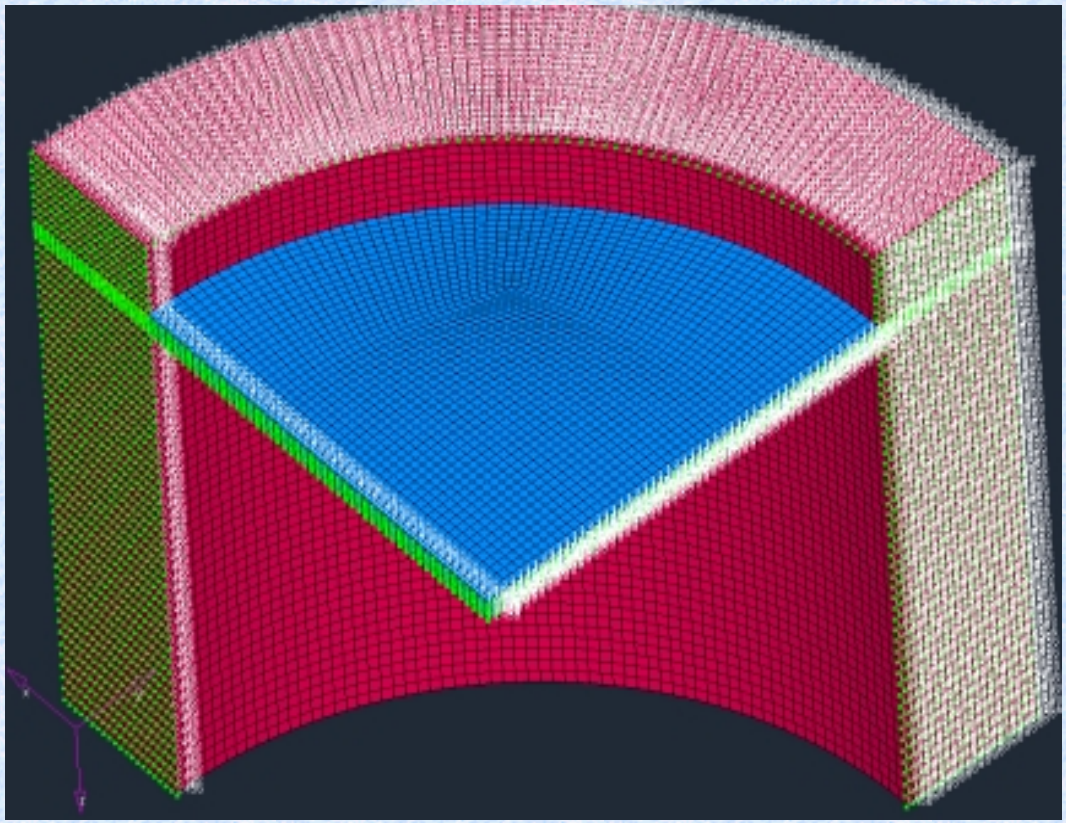
All dimensions are in cm

Material properties

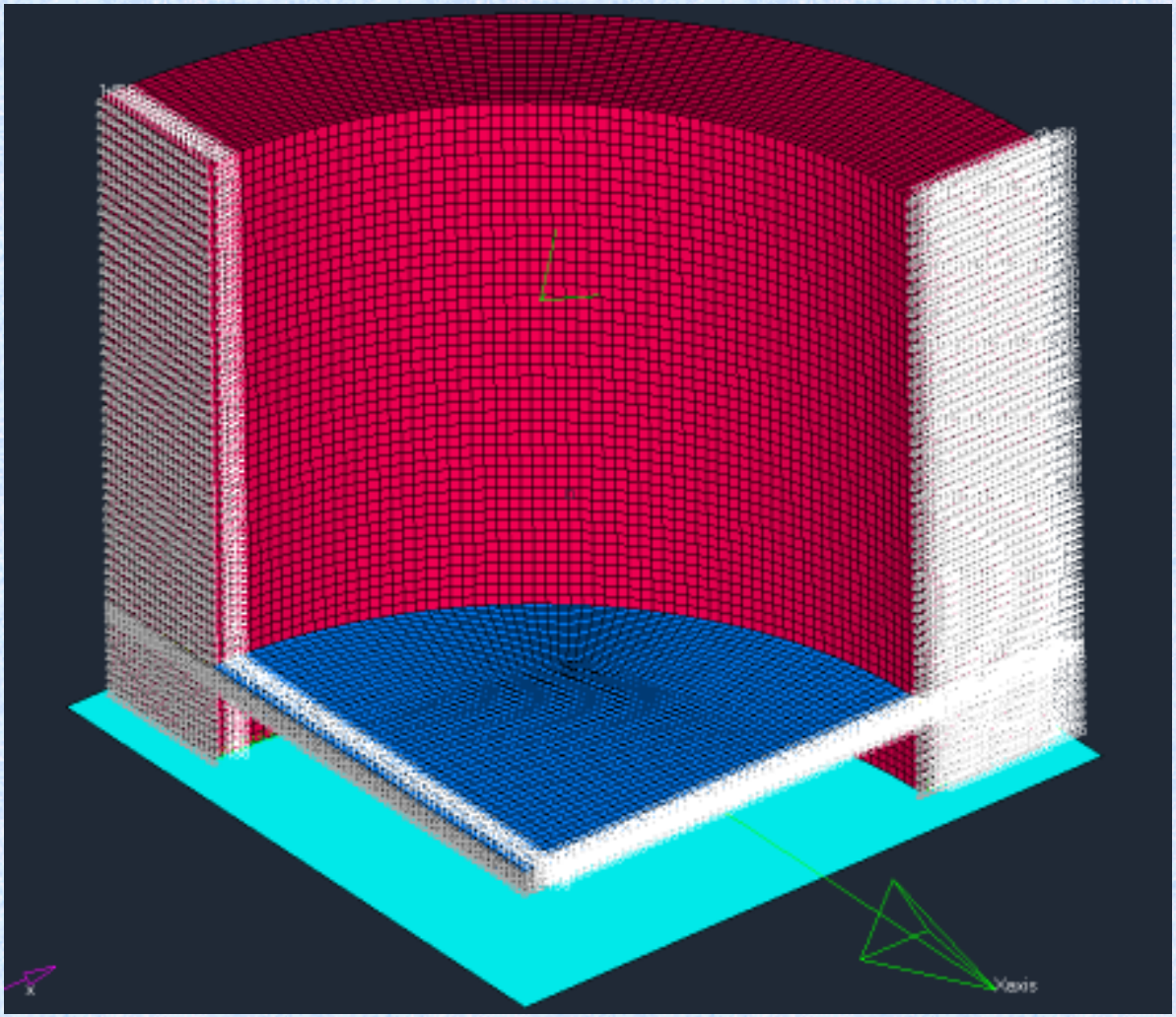
Aluminum		
Density	$\rho = 2.810\ E\text{-}6$	kg/mm^3
Young's modulus	$E = 72E+3$	N/mm^3
Yield strength	$\sigma y = 505$	N/mm^2
Poisson ratio	$\mu = 0.33$	
Fiberglass composite		
Density	$\rho = 1.820\ E\text{-}6$	kg/mm^3
Young's modulus	$Ea = 19.719\ E+3$	N/mm^3
	$Eb = 19.719\ E+3$	N/mm^3
	$Ec = 9.101\ E+3$	N/mm^3
Shear modulus	$Ga = 3.702\ E+3$	N/mm^2
	$Gb = 2.9026\ E+3$	N/mm^2
	$Gc = 2.9026\ E+3$	N/mm^2
Poisson ratio	$\mu a = 0.33$	
	$\mu b = 0.33$	
	$\mu c = 0.33$'	

Meshing and boundary condition

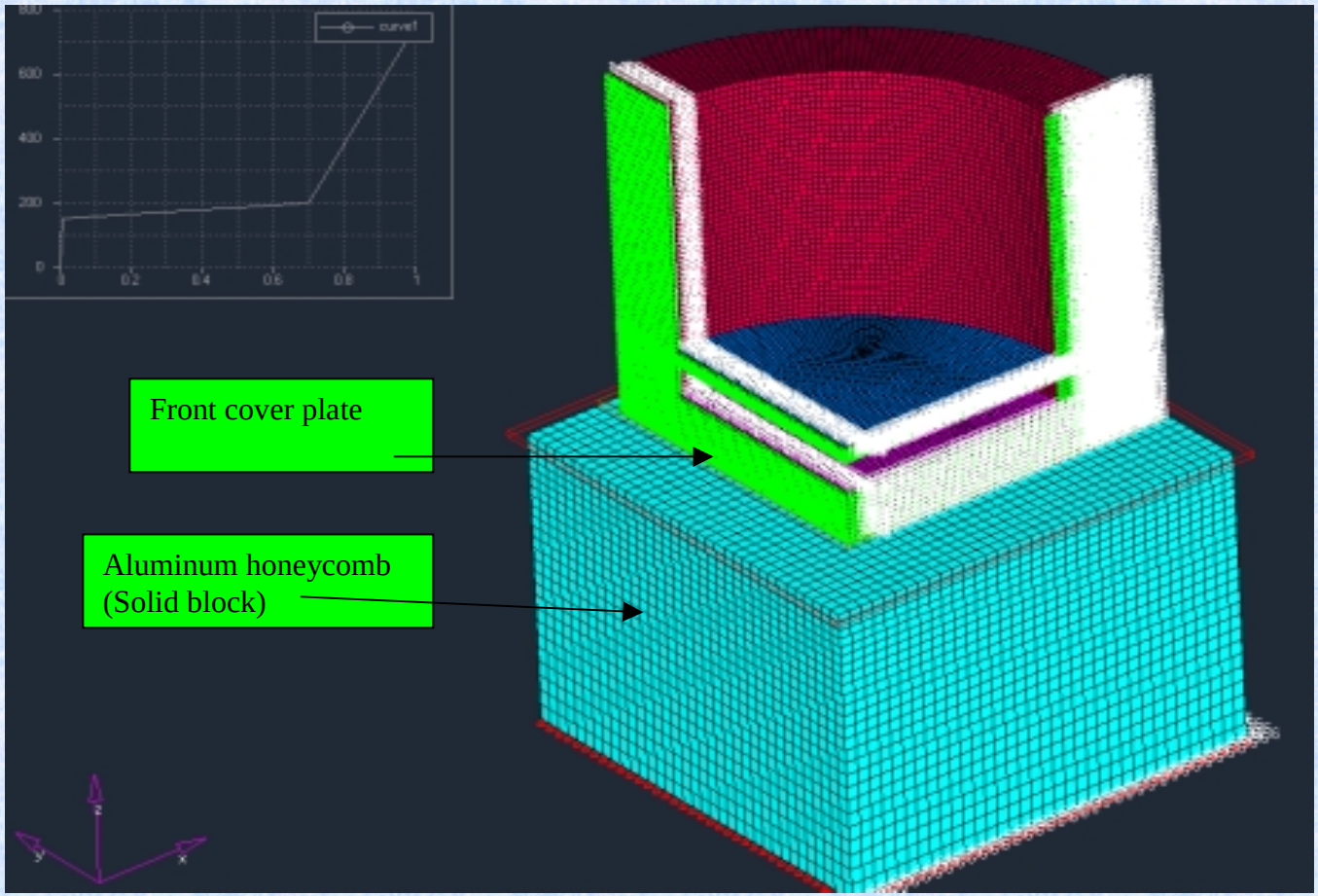
Case-1 Cylinder with one end fixed



Case-2 Cylinder impact on rigid wall



Case-3 Cylinder impact on the aluminum honeycomb



Boundary condition

Case-1: - Cylinder with front end fixed

Boundary condition	Tx	Ty	Tz	Rx	Ry	Rz
X-Z symmetry plane		0		0	0	0
Y-Z symmetry plane	0			0	0	0
Cylinder front end			0	0	0	0

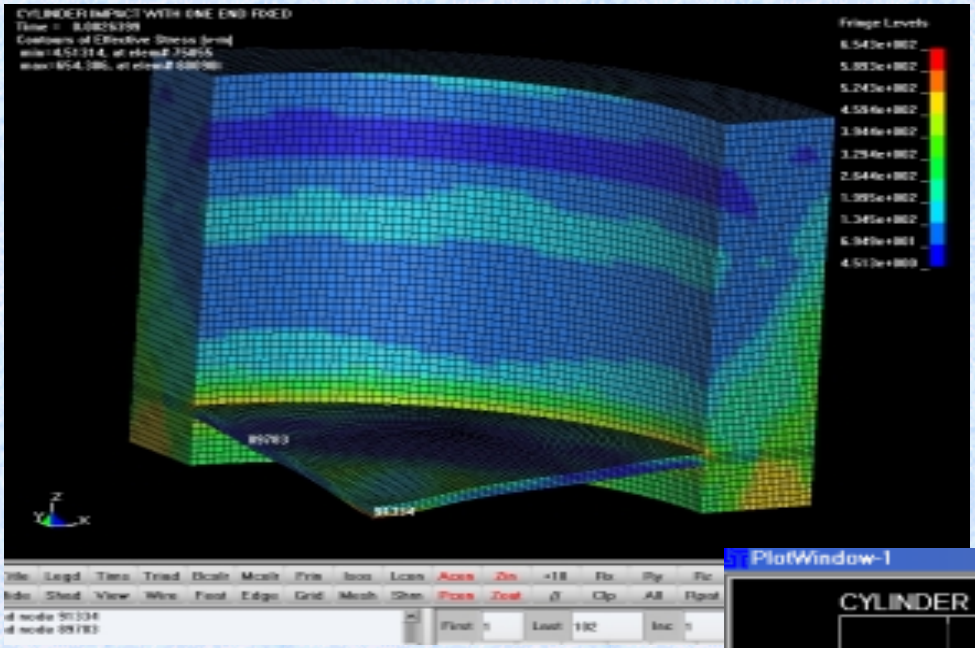
Case-2: - cylinder impact on rigid wall

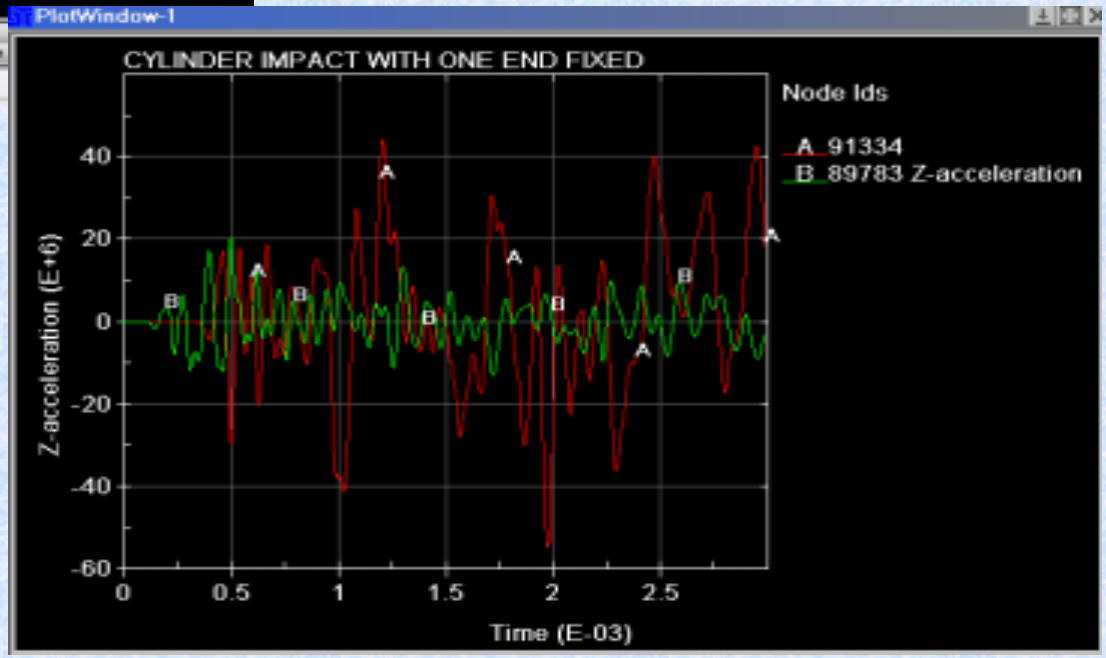
Boundary condition	Tx	Ty	Tz	Rx	Ry	Rz
X-Z symmetry plane		0		0	0	0
Y-Z symmetry plane	0			0	0	0

Case-3: - Cylinder impact on aluminum honeycomb

Boundary condition	Tx	Ty	Tz	Rx	Ry	Rz
Cylinder, X-Z symmetry plane		0		0	0	0
Cylinder, Y-Z symmetry plane	0			0	0	0
Solid block's bottom surface	0	0	0	0	0	0

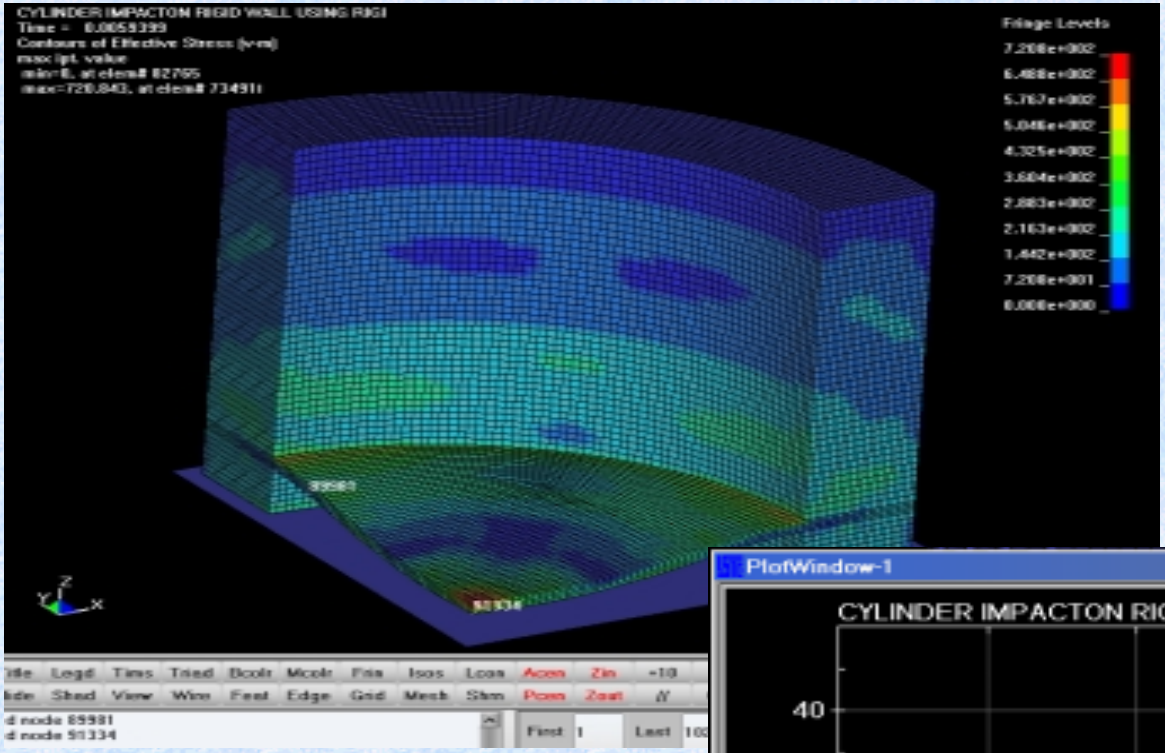
Case-1: - Cylinder with front end fixed

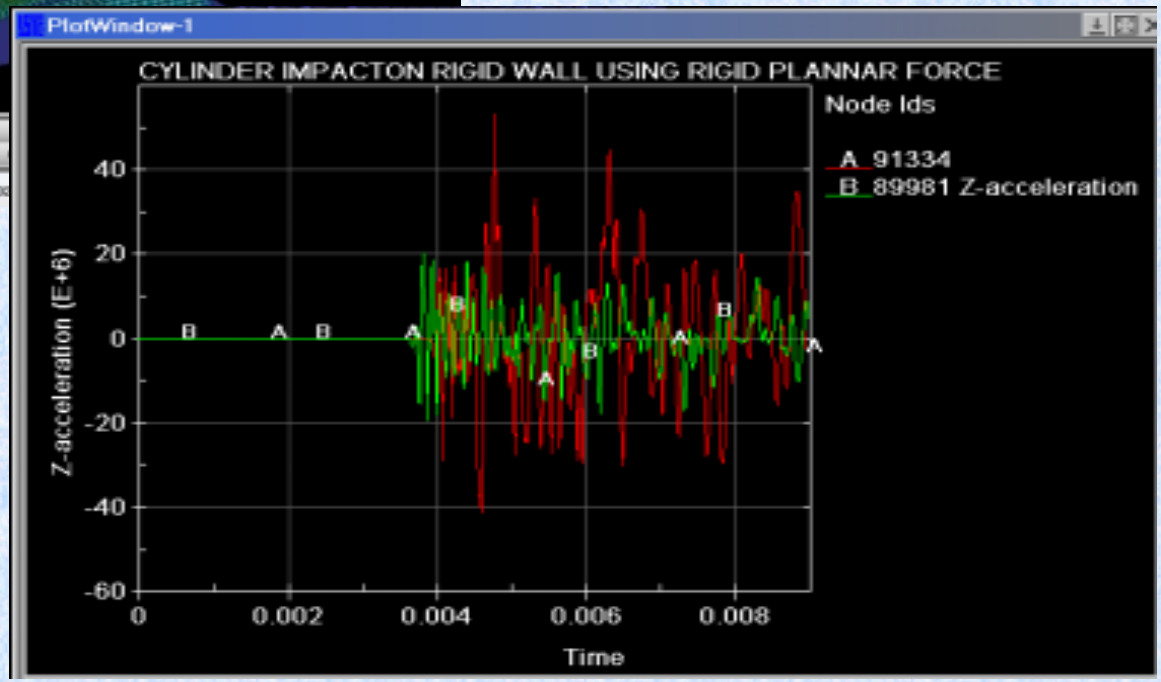




Stress wave propagation and acceleration plot

Case-2: - Cylinder impact on rigid wall





Stress wave propagation and acceleration plot

Case-3: - Cylinder impact on aluminum honeycomb

Case-31

E =18 GPa
Specific gravity =2

Strain	Stress (N/mm^2)
0	0
0.0084	151.5
0.7	200
1	750

Case-32

E =4 GPa
Specific gravity =2

Strain	Stress (N/mm^2)
0	0
0.01875	75
0.7	100
1	500

Case-33

E =1 GPa
Specific gravity =2

Strain	Stress (N/mm^2)
0	0
0.05	50
0.6	75
1	400

Case-34

E =1 GPa
Specific gravity =2

Strain	Stress (N/mm^2)
0	0
0.025	25
0.5	50
1	300

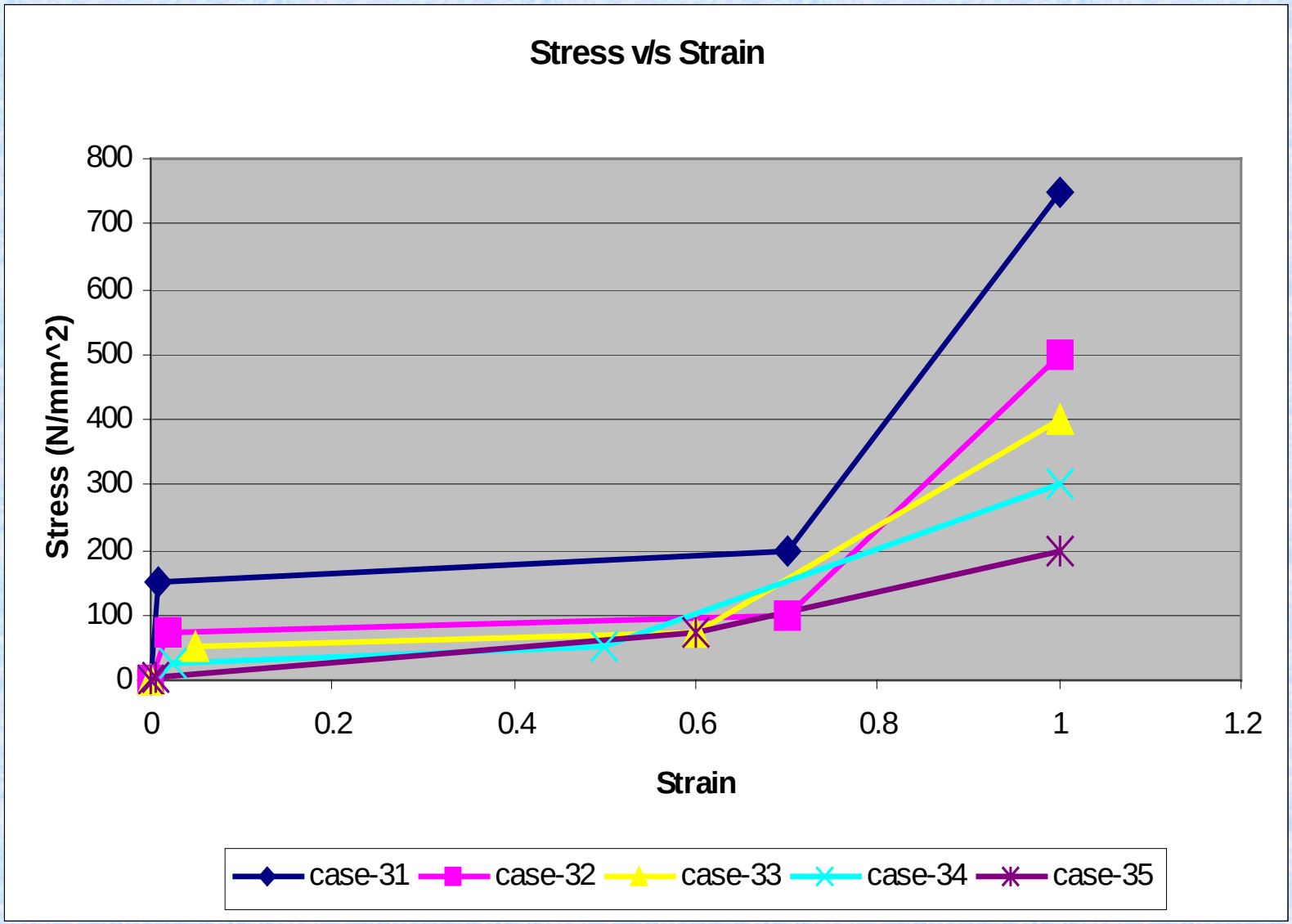
Case-35

E =1 GPa
Specific gravity =2

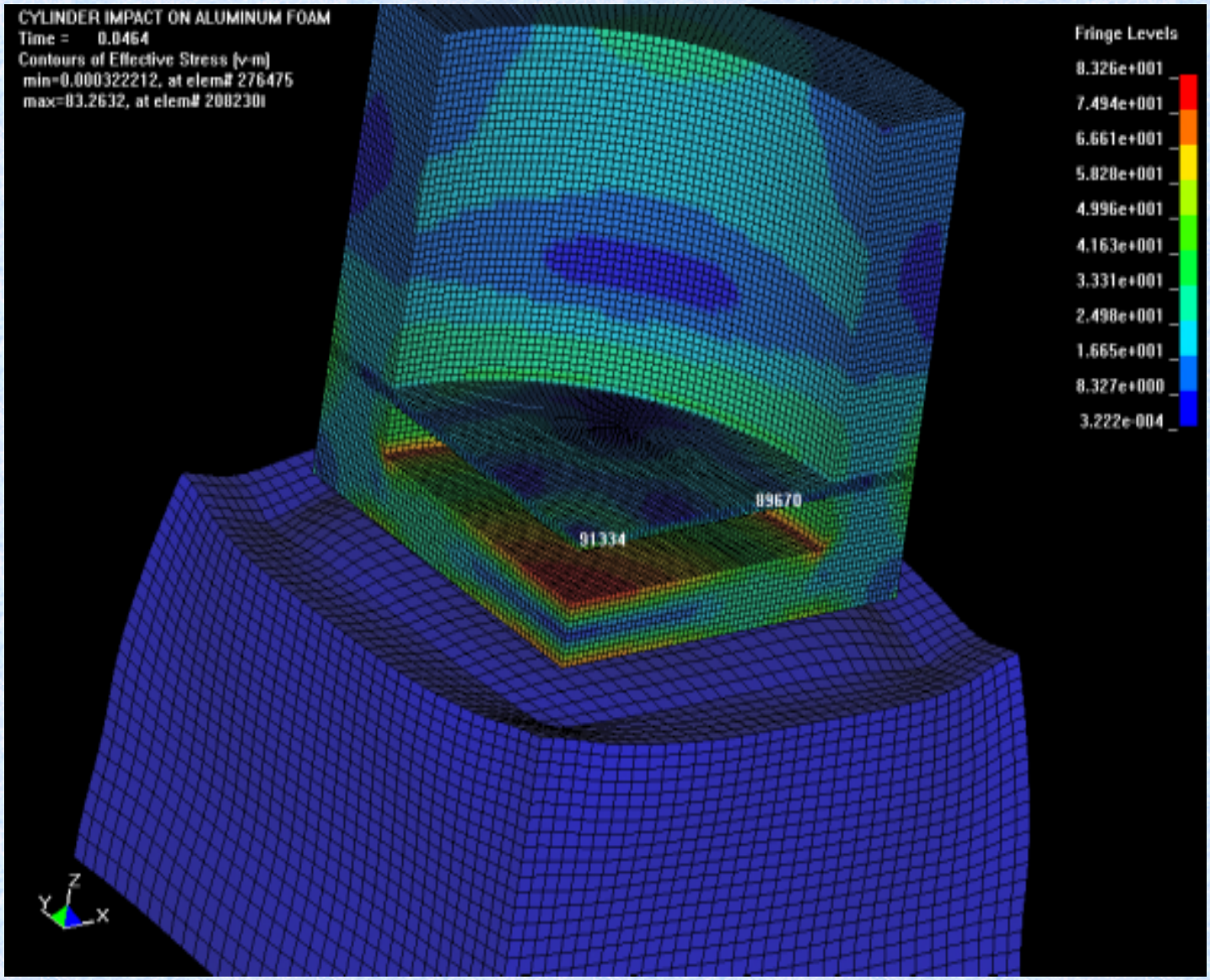
Strain	Stress (N/mm^2)
0	0
0.005	5
0.6	75
1	200

Five cases are studied with different material properties for aluminum honeycomb

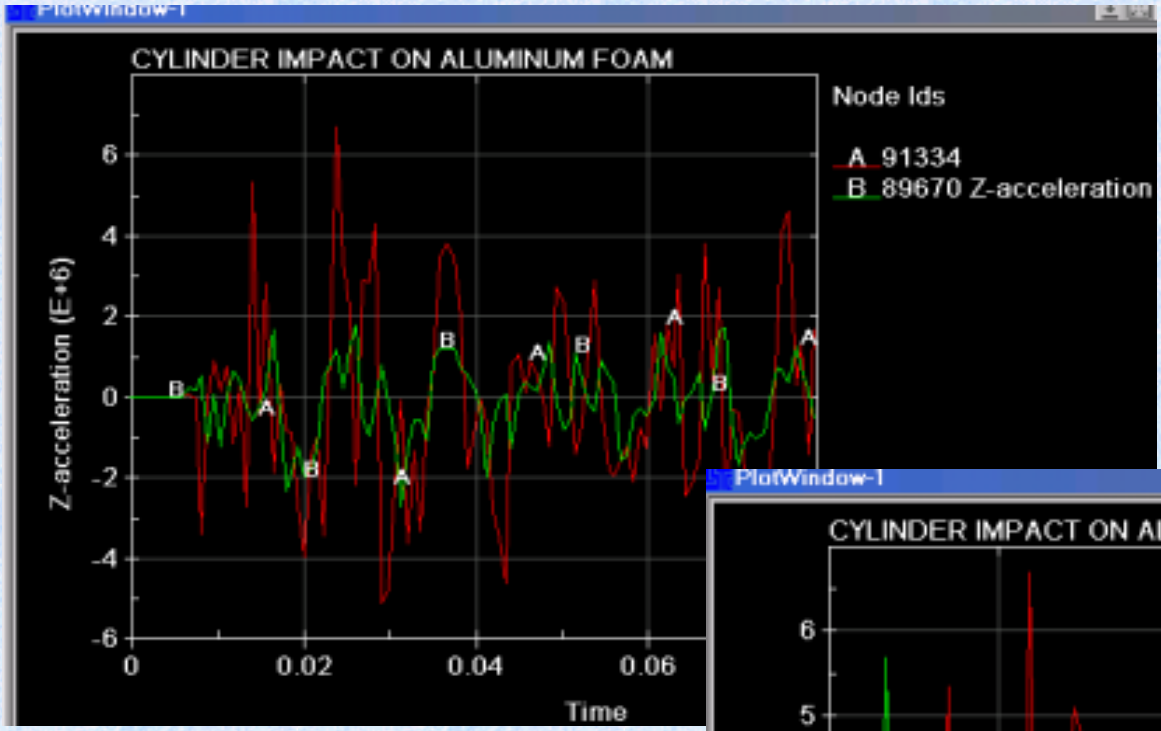
Stress v/s strain diagram for five case

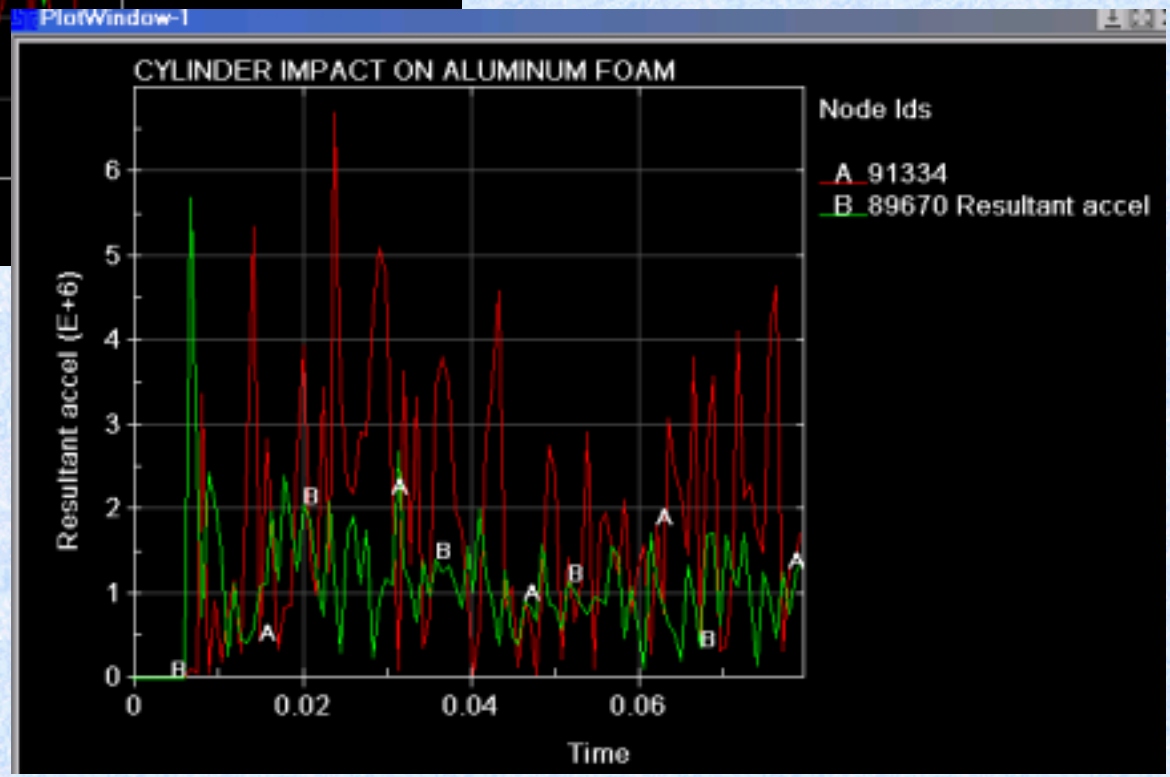


Stress wave propagation on cylinder impacting with honeycomb

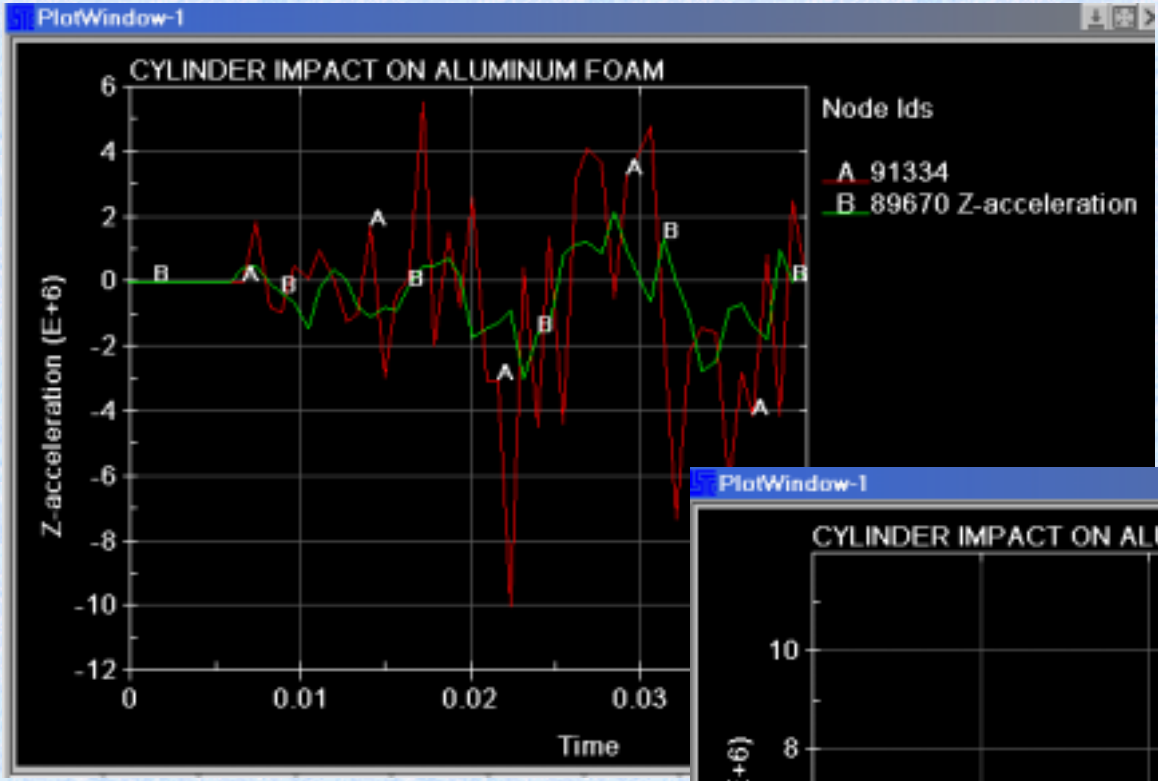


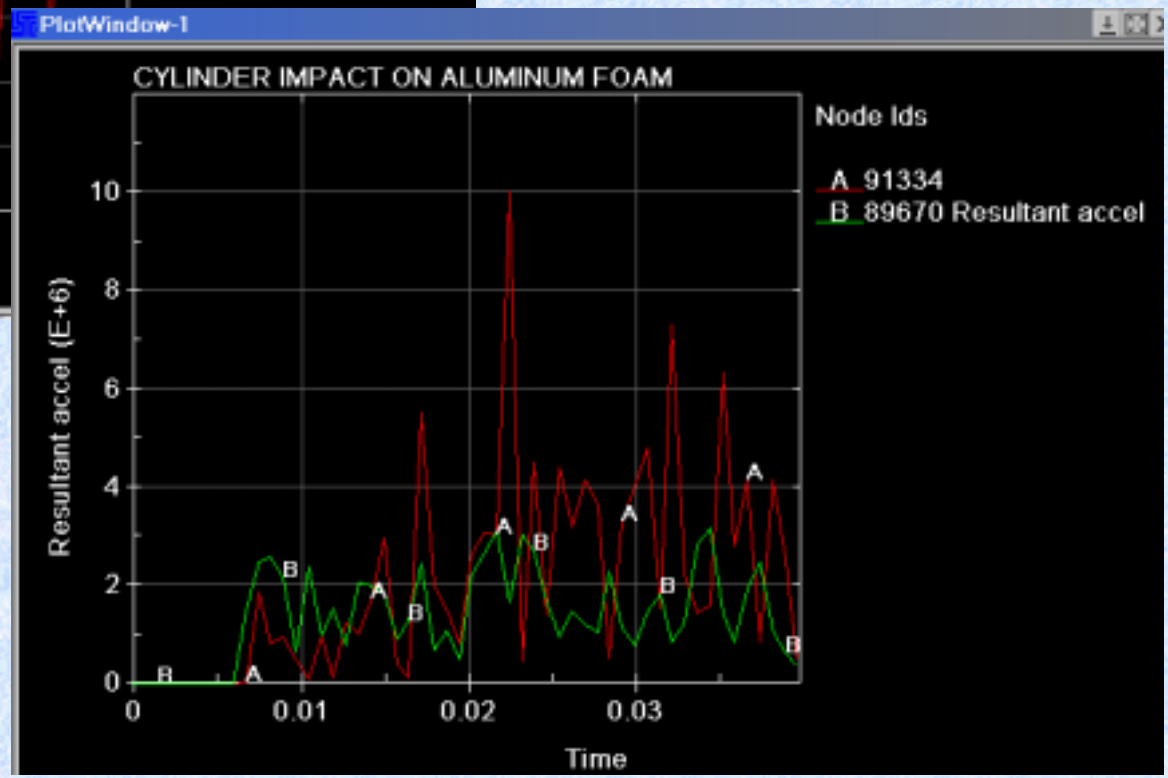
Z acceleration and resultant acceleration for case-31



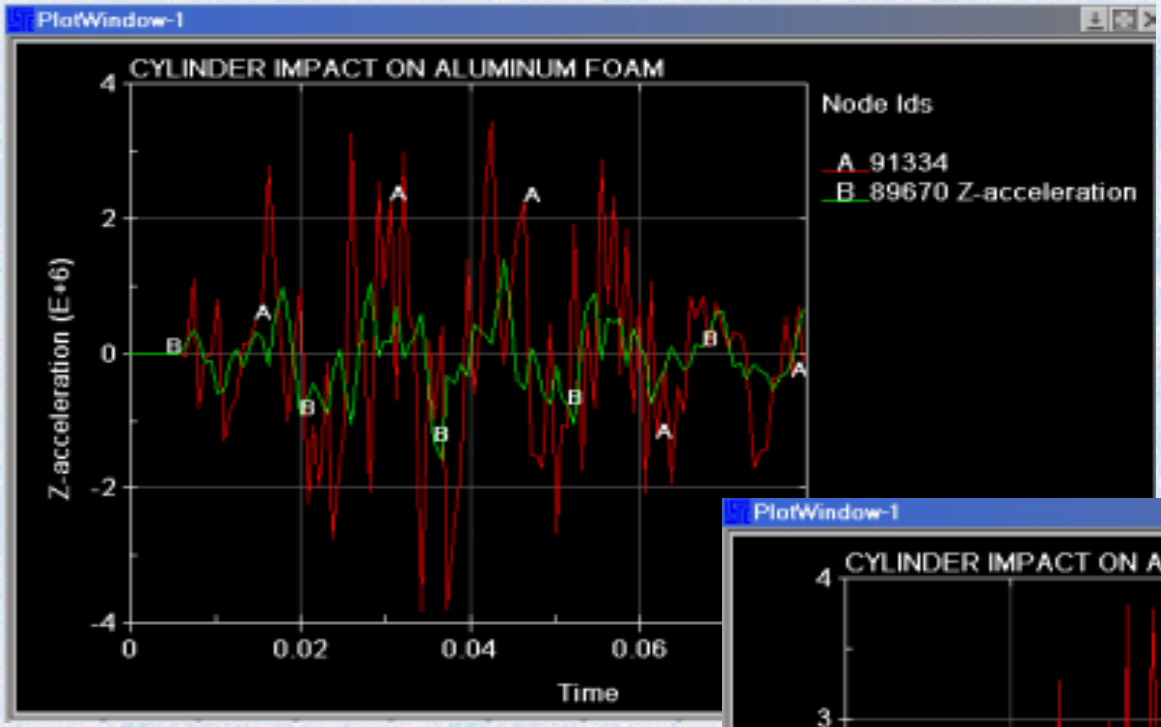


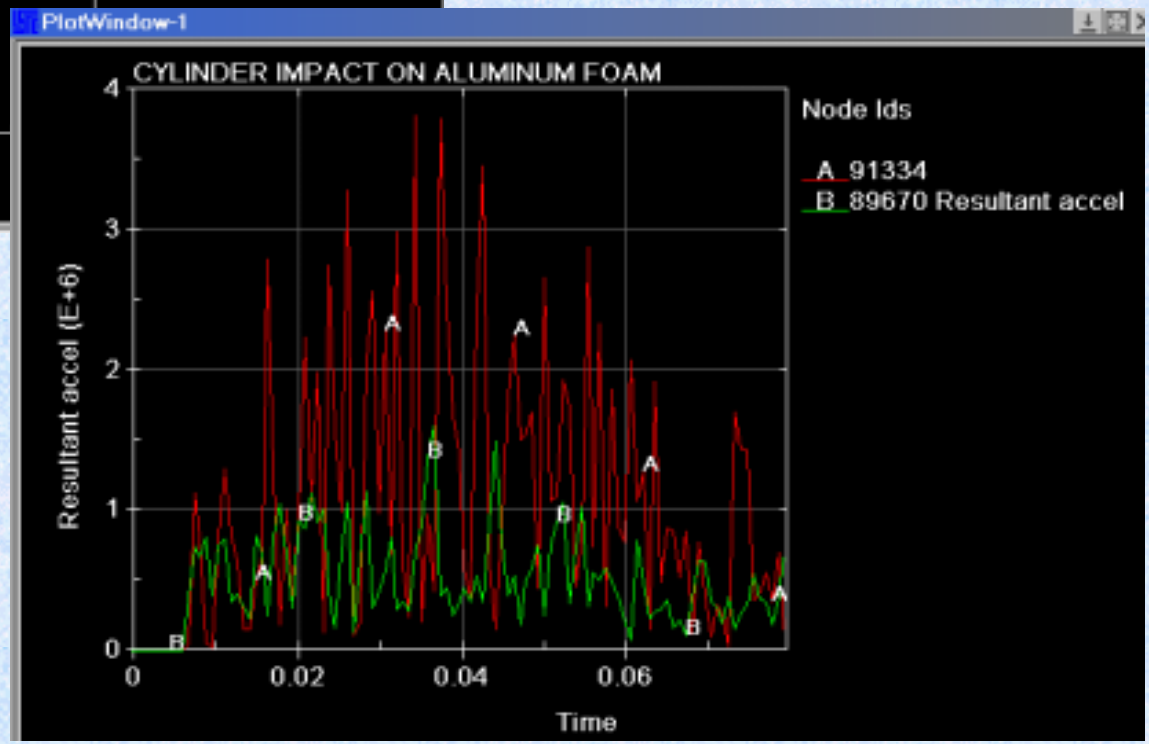
Z acceleration and resultant acceleration for case-32



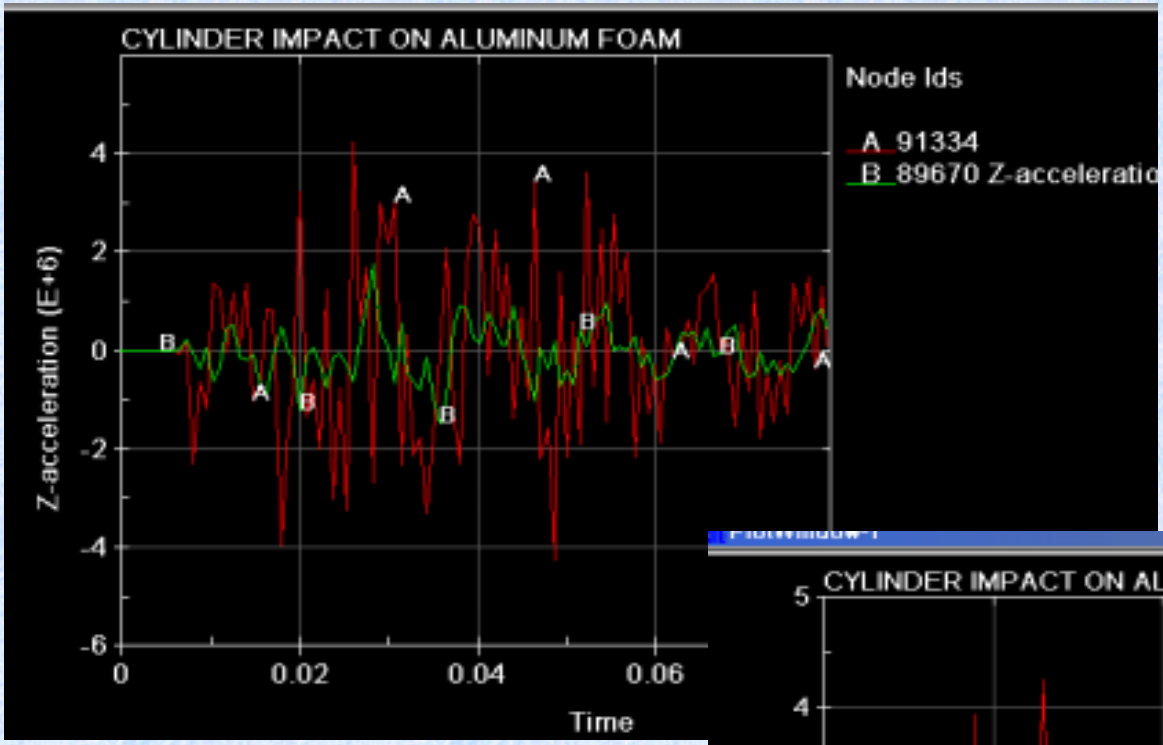


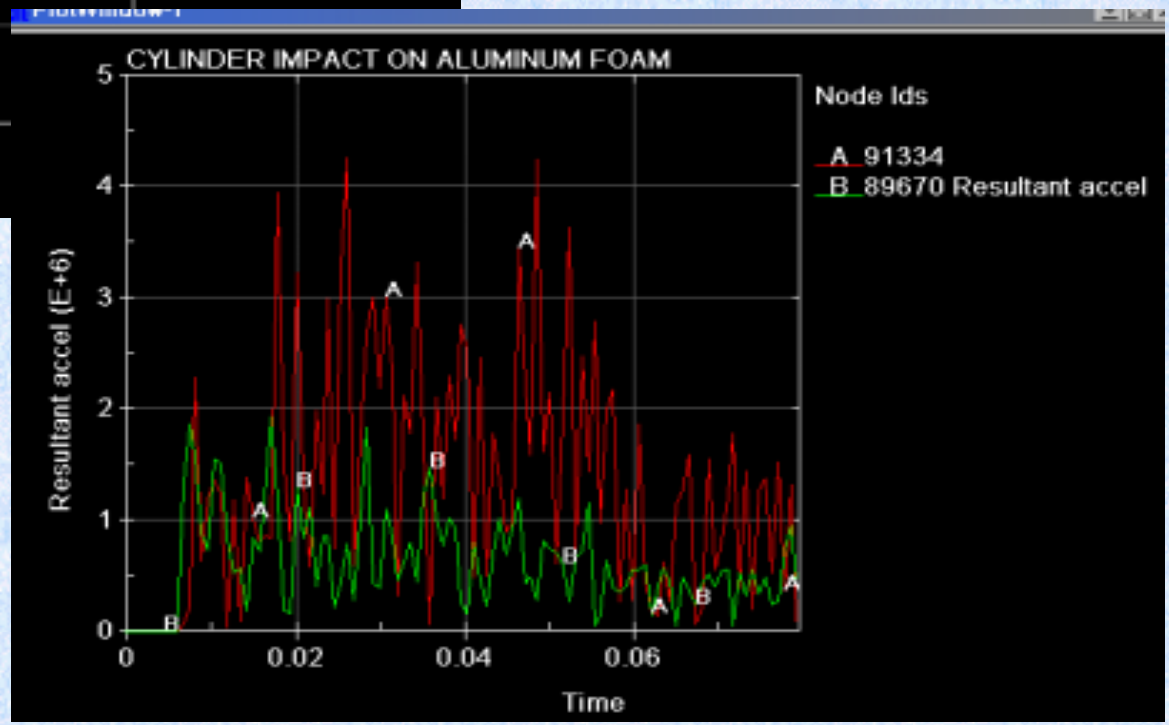
Z acceleration and resultant acceleration for case-33



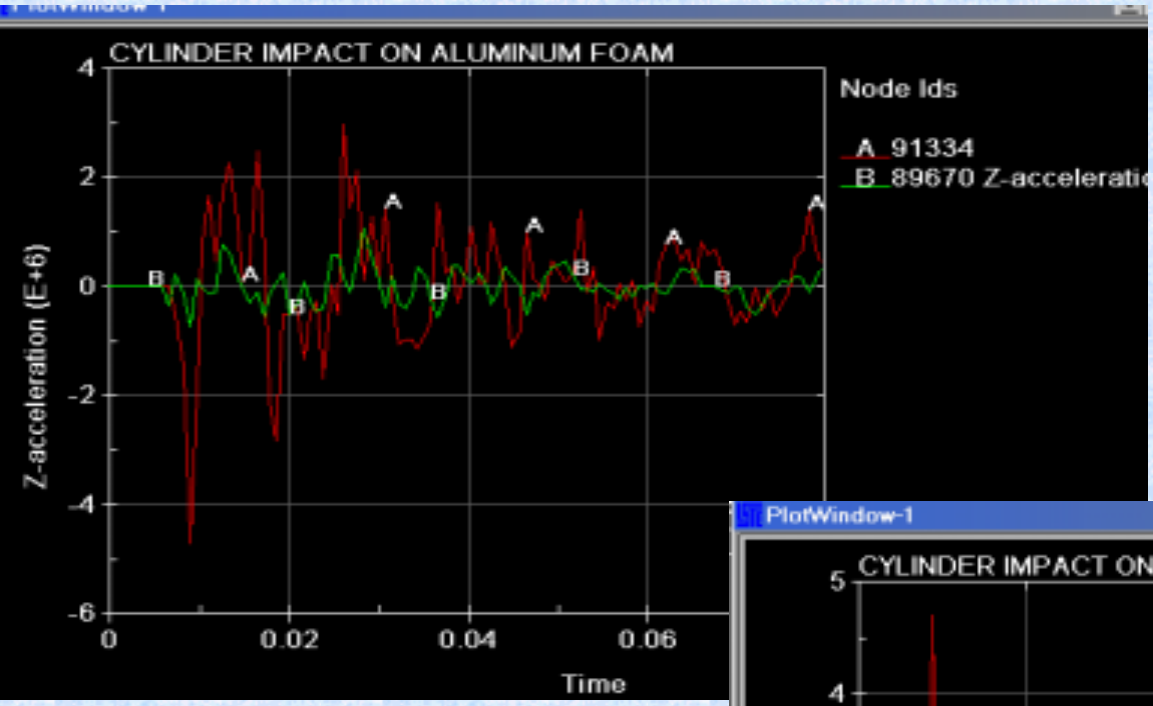


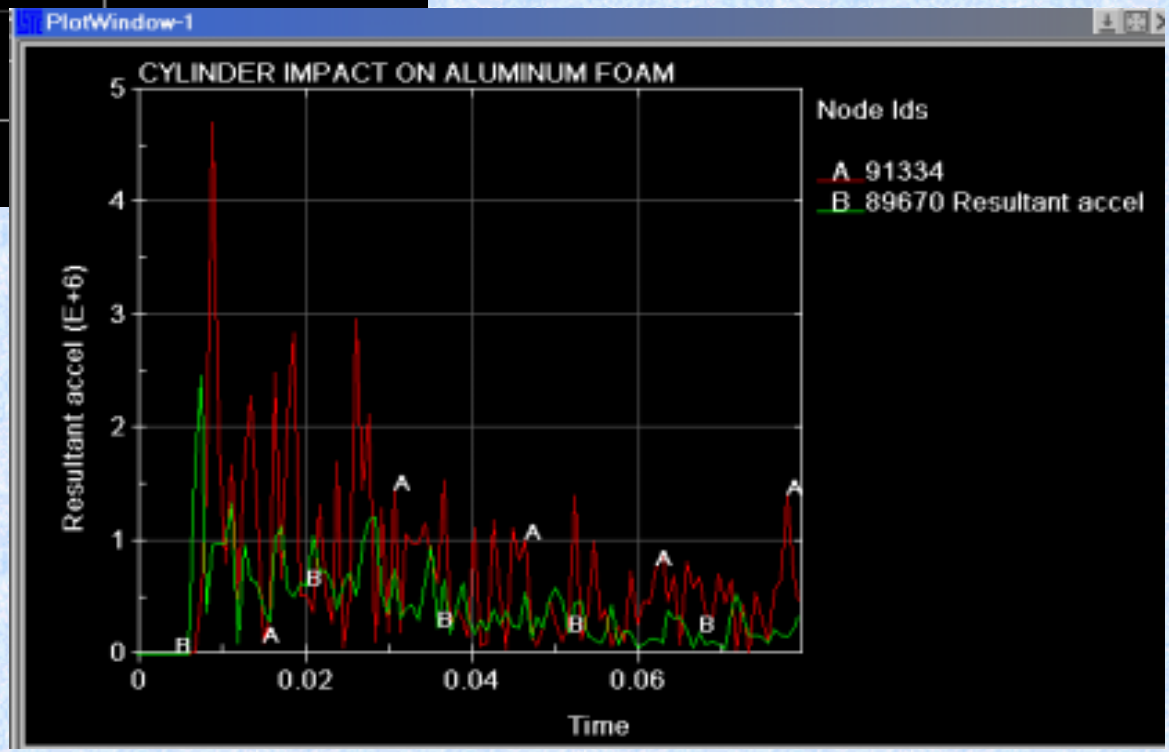
Z acceleration and resultant acceleration for case-34





Z acceleration and resultant acceleration for case-35





Conclusion

- The fifth case (Case-35) acceleration profile (resultant acceleration and Z-acceleration) is better when compared to other cases.

- The acceleration is gradually decreasing with time.

Future plans

- Increase the height of honeycomb
- Increase the run time and verify the acceleration profile for five cases
- Conducting cylinder impact test for verifying the computational results

Acknowledgement

Dr. **Brendan J. O'Toole**