



MSTV

MODELING AND SIMULATION, TESTING AND VALIDATION



*Analysis Comparison between CFD and FEA of an Idealized Concept
V- Hull Floor Configuration in Two Dimensions*

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Report Documentation Page

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14. ABSTRACT Several possibilities have been investigated that include studies with Courant number setting, Supersonic Static Pressure setting that shows Finite Volume and Finite Element results can be equivalent The Effect of Mesh Density on Force prediction has been demonstrated A 2-D type of analysis has been demonstrated to mimic that of a full 3-D analysis and are effective for what-if scenarios					
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- ***Outline***
- ***Introduction***
- ***Model***
- ***Analysis***
- ***Results Comparison***
- ***Conclusion***



- ***Outline:***

> An idealized concept of a V-hull vehicle design for blast analysis has been studied in two different commercial software packages StarCCM+ & LS-DYNA

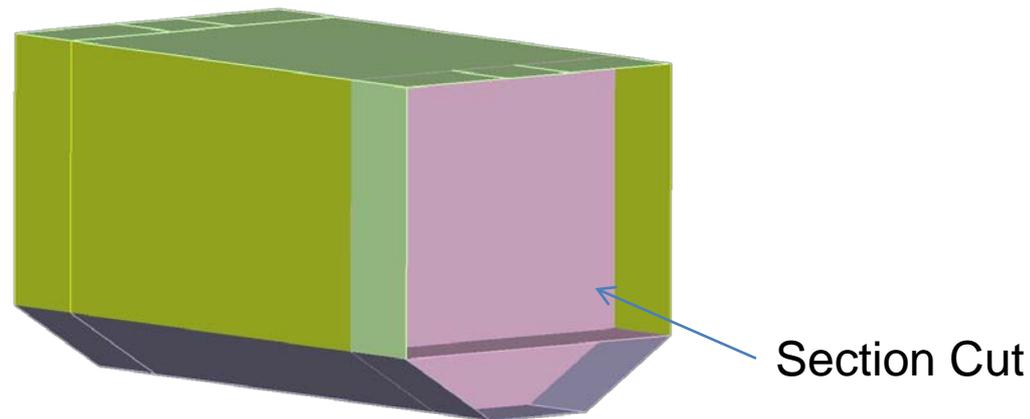
StarCCM+ is : Eulerian ; Finite Volume

LS-DYNA is: Lagrangian /ALE; Finite Element



- **Introduction:**

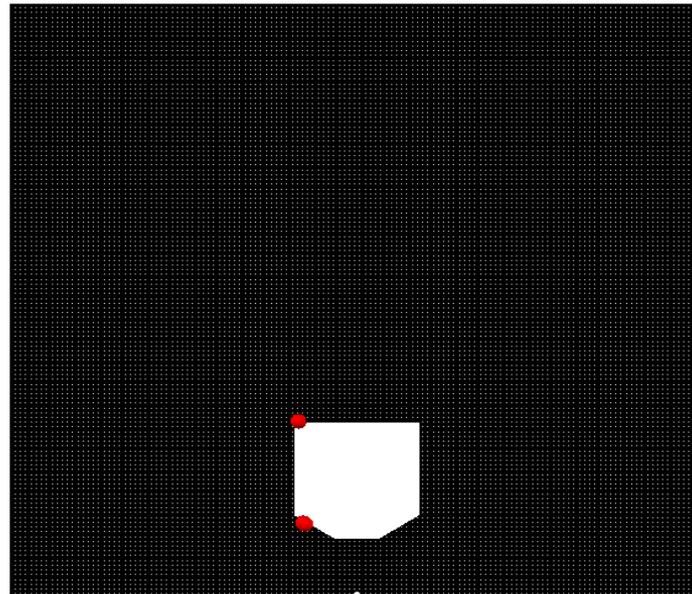
A section cut from a generic 3-D model is used study the pressure, velocity and temperature distribution due to the blast effect under the vehicle





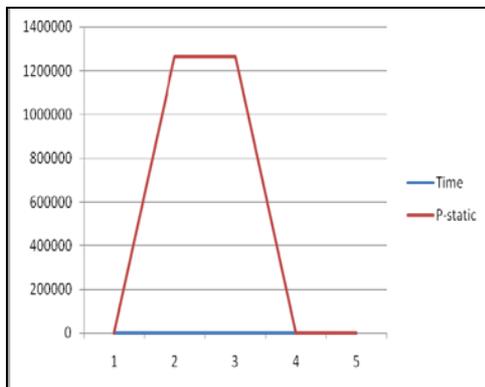
- **Model:**

A 2-D vertical cut has been made from the 3-D vehicle and the following Initial and Boundary Conditions have been applied to the model

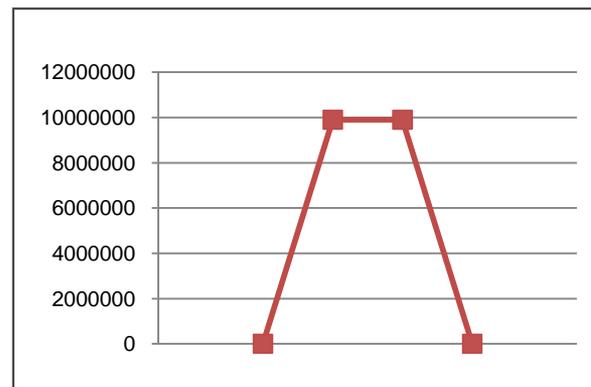




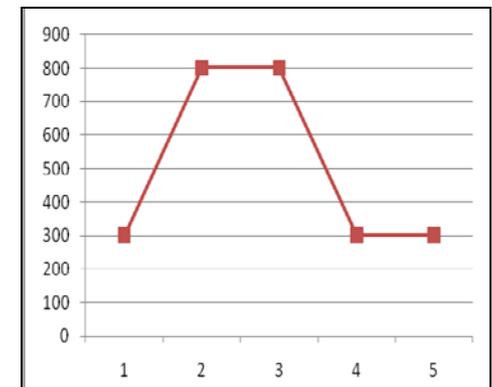
- **Model:**
 - StarCCM+
 - Initial Conditions



Static Supersonic Pressure Pulse



Total Pressure Pulse



Temperature Pulse



- **Model:**

- **LS-DYNA Initial Conditions**

- Initial loading condition required a conversion from total pressure to the relative volume using the ideal gas law

***V(Stands for Relative Volume) = Initial density / density.
And***

Density = Pressure / (Cp-Cv) * T (stands for Temperature)

Cp = Specific heat under constant pressure

Cv = Specific heat under constant volume

***For Air during 1 ms to 10 ms, the value gets computed by
a Load Curve input :***

Density = 100 Bar / 286 * 800 Kelvin



- **Mesh:**

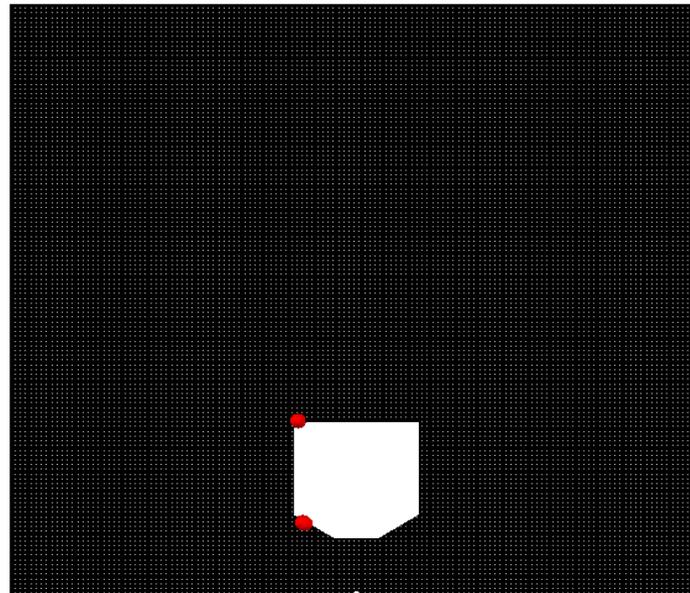
**3 levels of mesh were created for both
StarCCM+ and LS-DYNA models:**

- > 45,000 element (Cell)**
- > 145,000 element (Cell)**
- > 1,145,000 element (Cell)**



- **Analysis:**

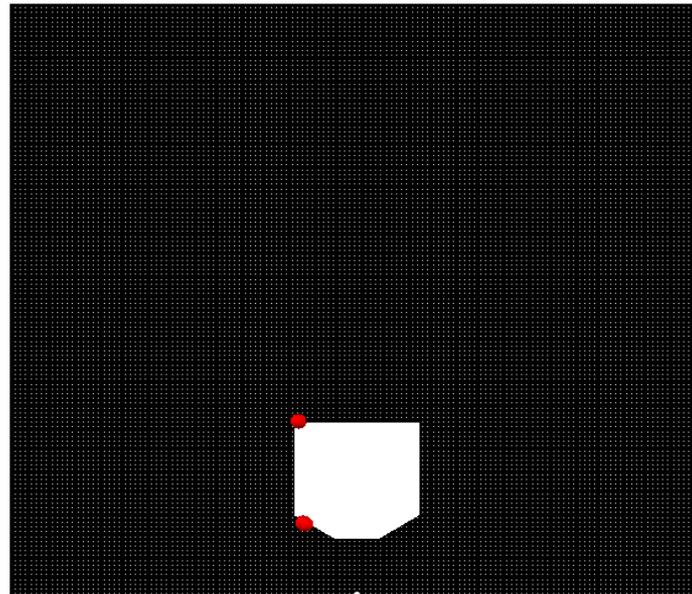
- Explicit-Unsteady-Non-Turbulent Analysis
- Both StarCCM+ and LS-DYNA
- Courant number of about 0.5 on both cases
- At 3 mesh levels





- **Analysis Cont':**

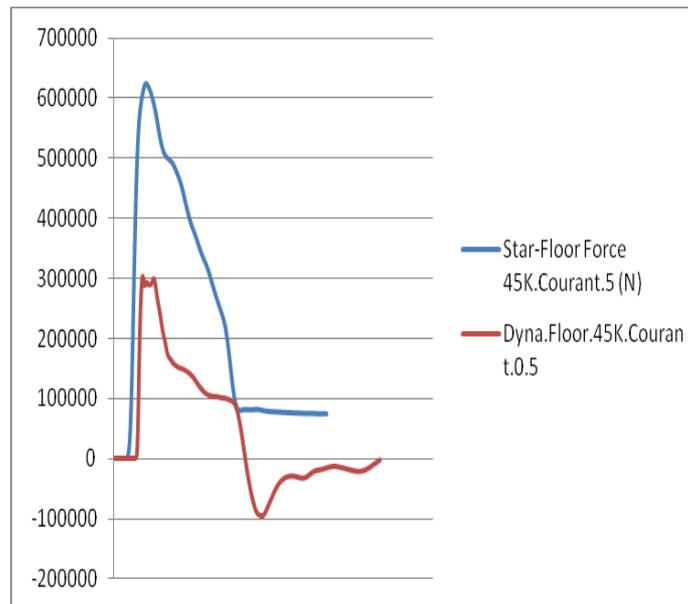
- Line segments on the Floor and the Roof were used to compute the resulting forces for comparison between cases



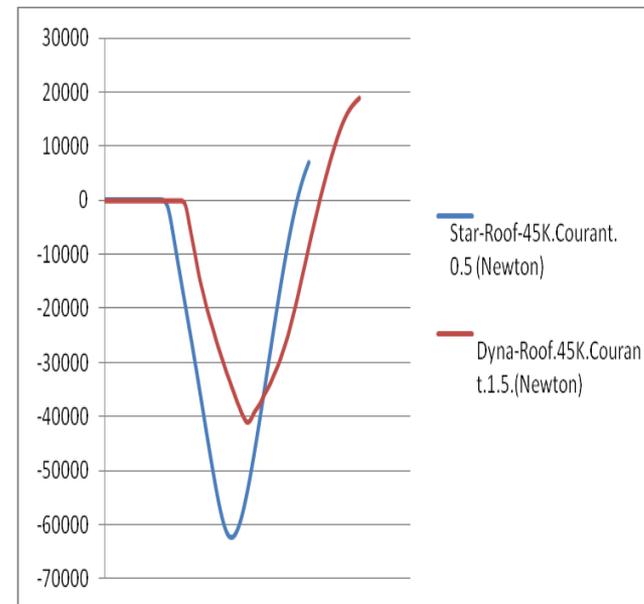


- **Results:**

- Lift forces on the Floor and the Roof were compared
- Qualitatively the results are comparable
- Quantitatively the peak and residual forces are distinct



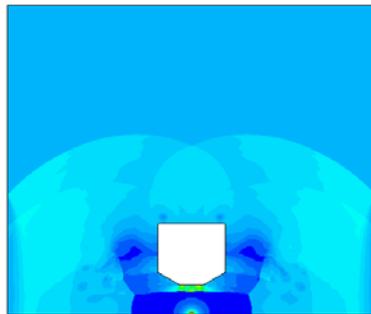
Floor Force



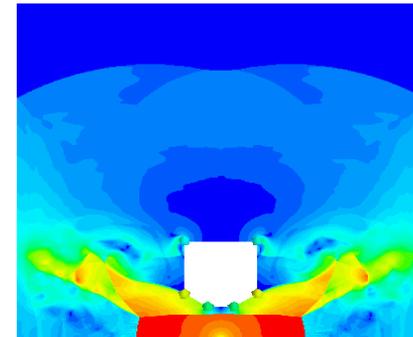
Roof Force



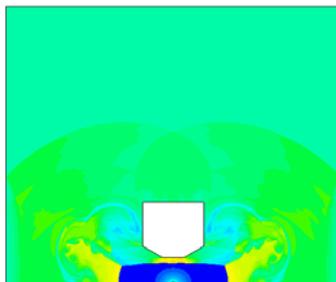
- StarCCM+ Results:



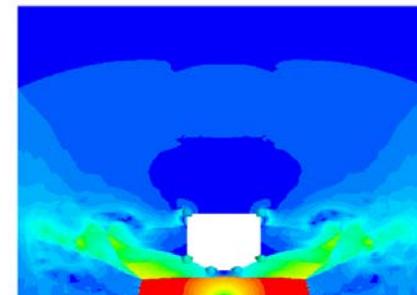
Pressure Distribution StarCCM+



Velocity Distribution StarCCM+



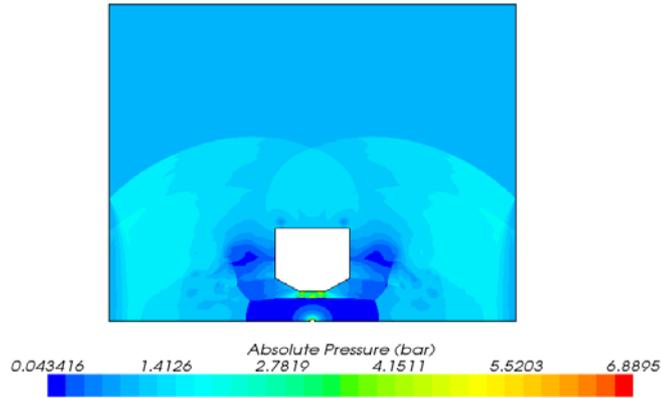
Temperature Distribution StarCCM +



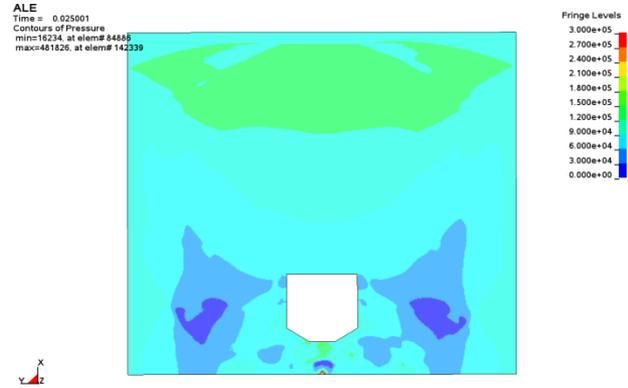
Mach No. Distribution StarCCM+



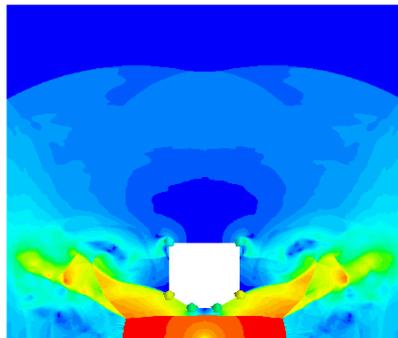
• **Result Comparison:**



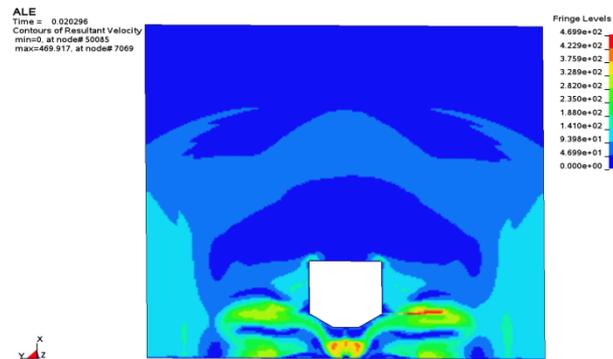
Star-CCM+ Pressure Distribution



LS-Dyna Pressure Distribution



Star-CCM+ Velocity Fluctuations



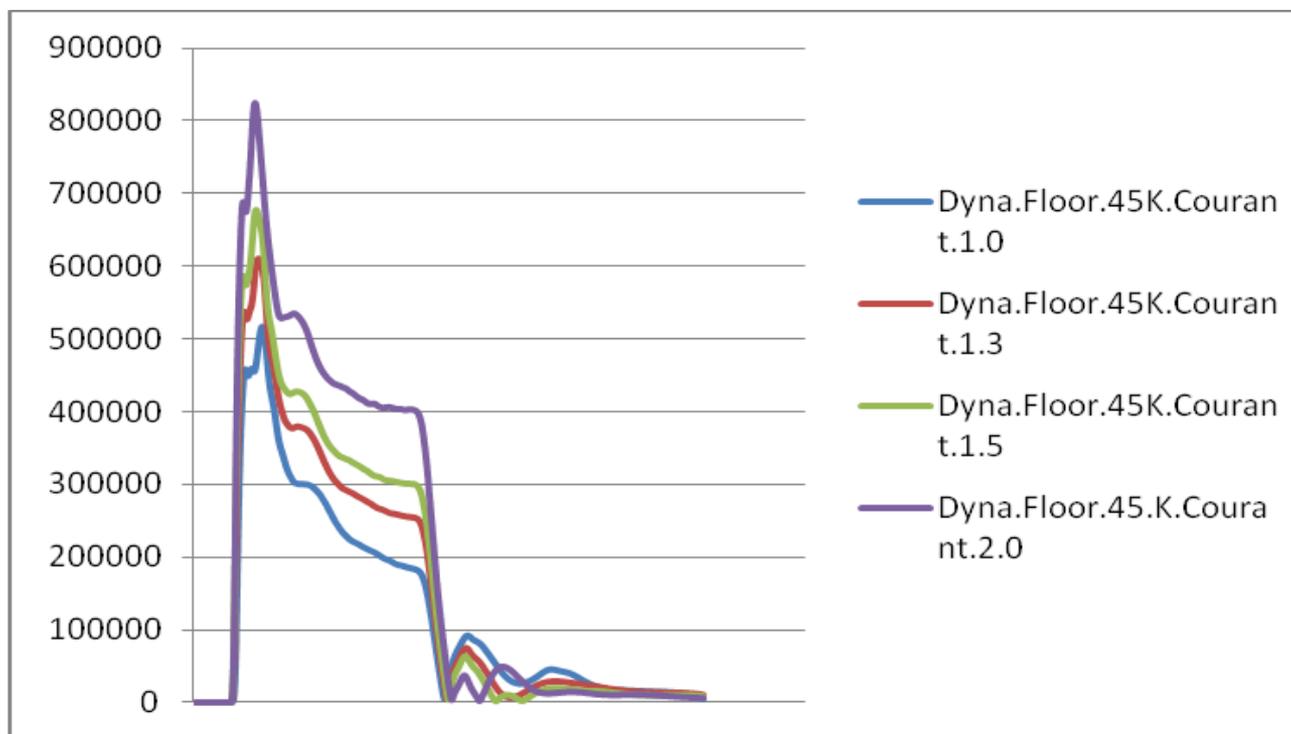
LS-Dyna Velocity Fluctuations



- ***The Effect of Courant Number:***
 - ***Few different time steps have been tried to investigate the effect of the Courant Number***



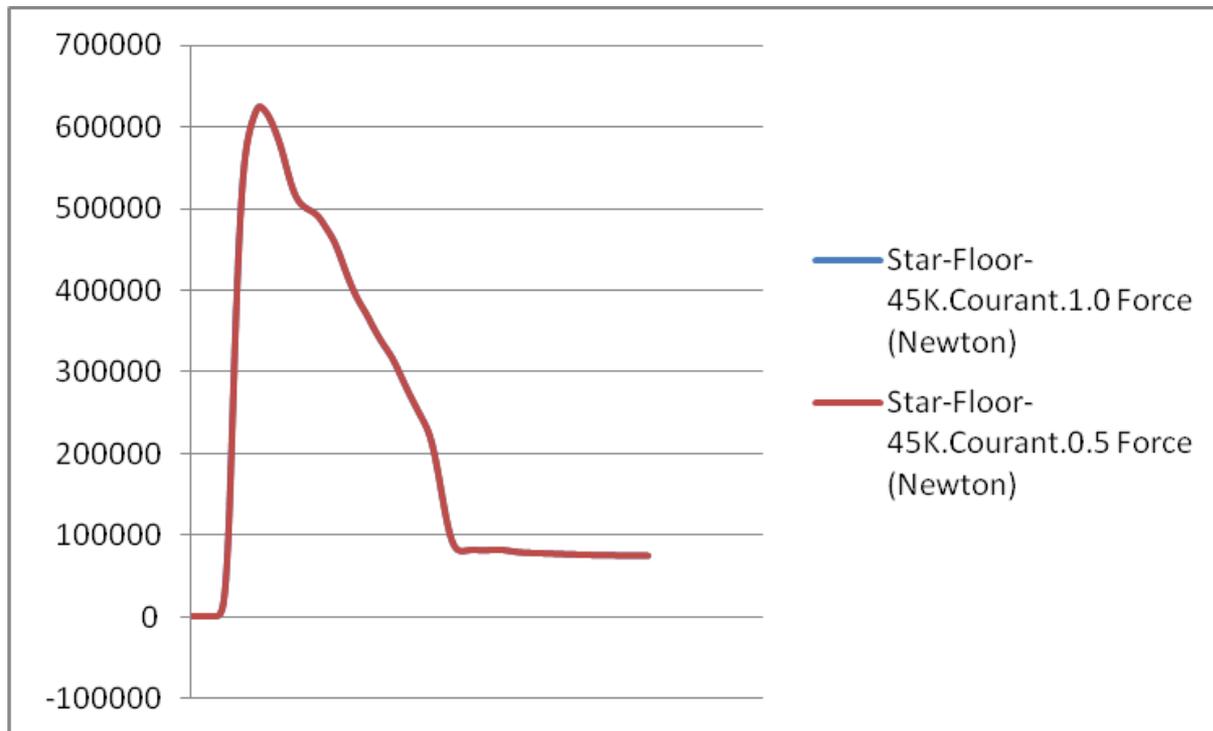
- Courant Number Effect: LS-DYNA**



Floor Force vs. Time



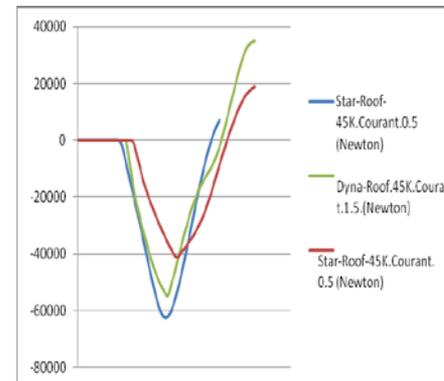
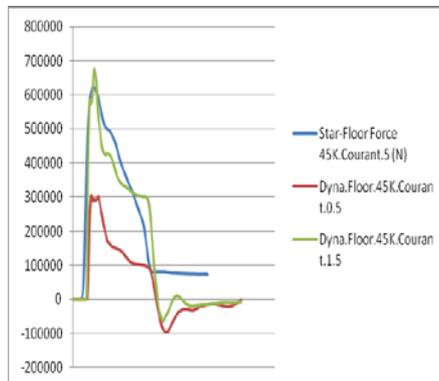
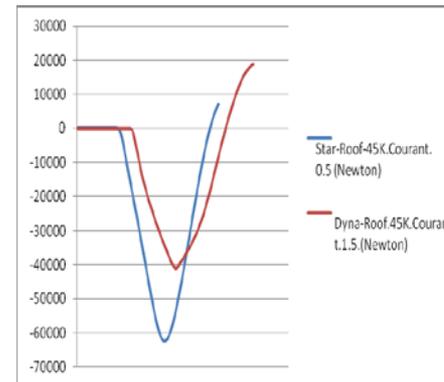
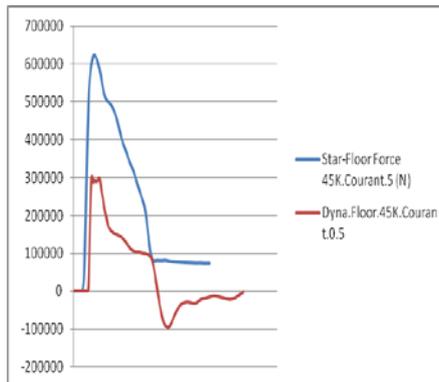
- Courant Number Effect: StarCCM+**



Floor Force Vs. Time



• **Courant Number: StarCCM+ vs LS-DYNA**



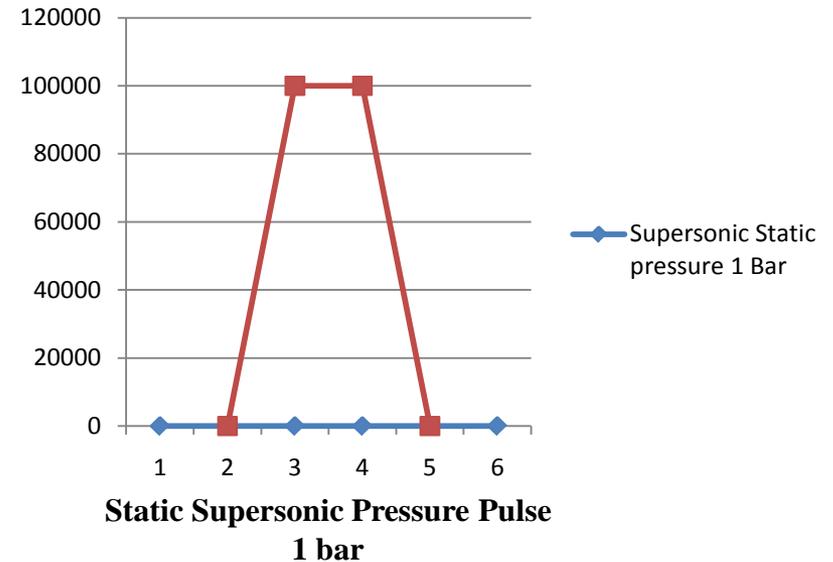
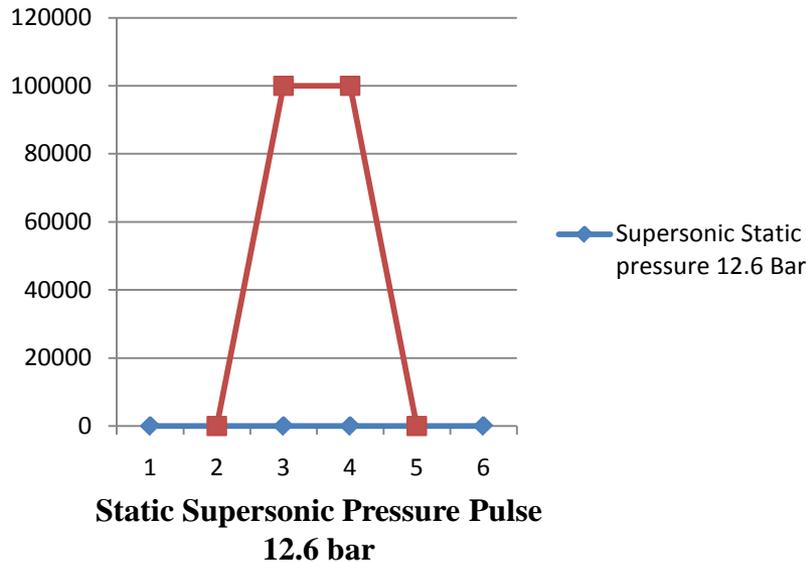
Floor

Roof



- Initial Condition Effect:**

- **The static supersonic pressure was reduced from 12.7 Bar to 1 Bar in StarCCM+ to match the Total pressure of 100 Bar in both StarCCM+ and LS-DYNA as input**

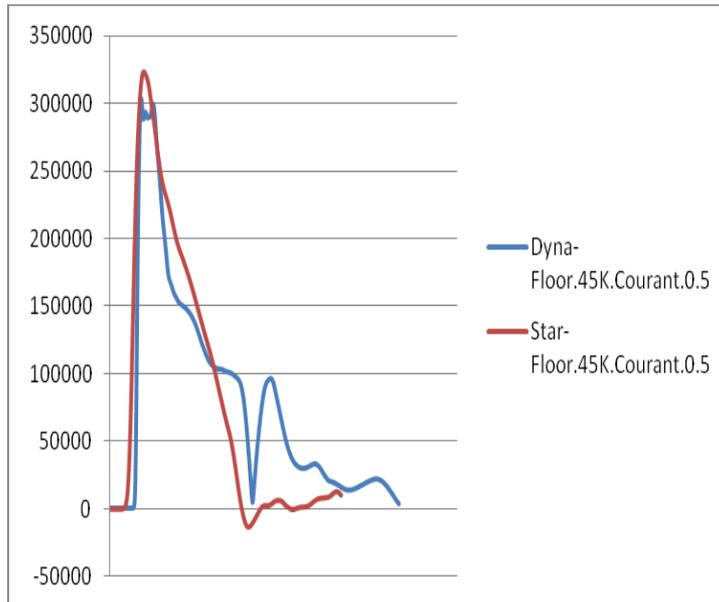




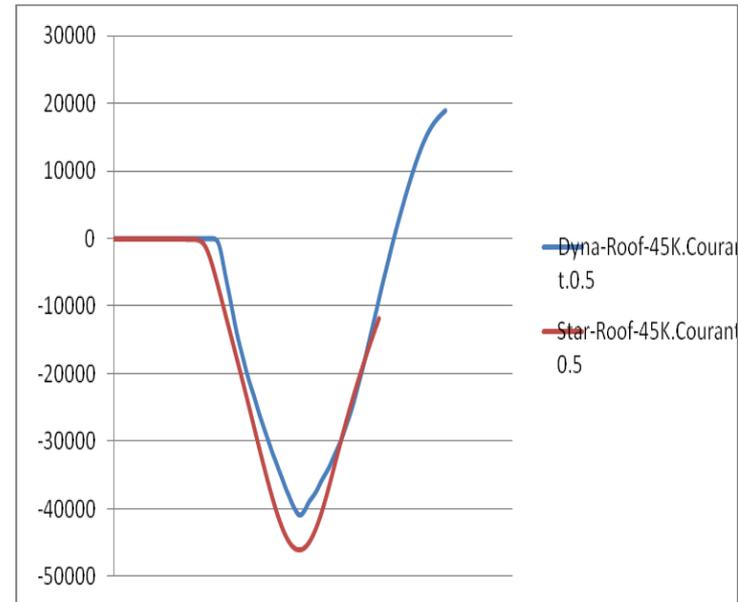
- **Supersonic Static Pressure :**

LS-DYNA vs StarCCM+

Floor force Vs. Time when Supersonic Static Pressure is set to 1.0 Bar



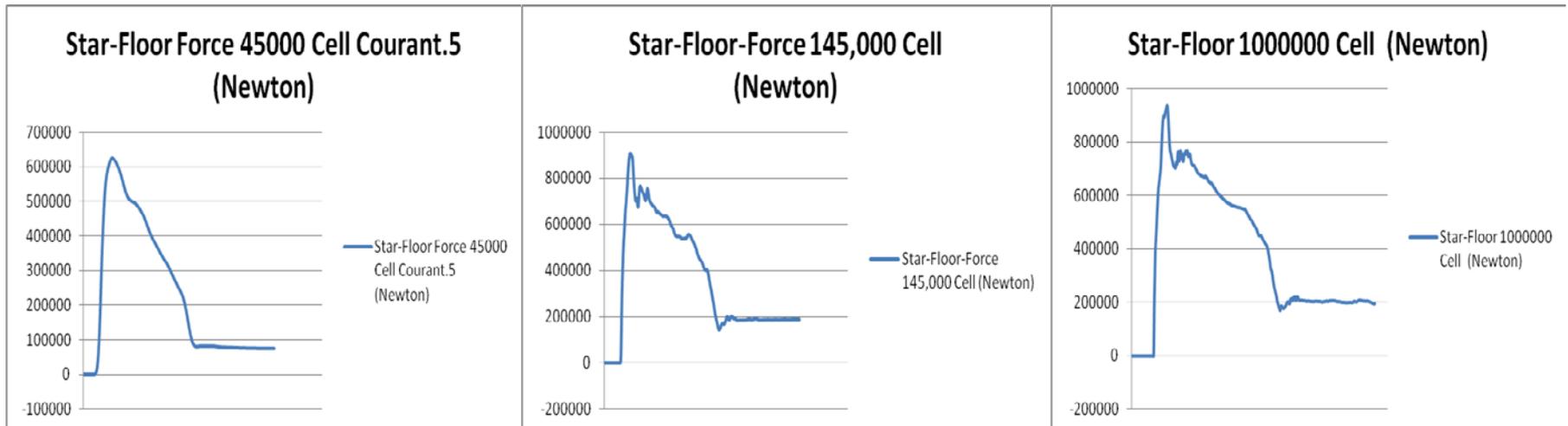
Floor Force



Roof Force



- **Mesh Density Study:**
 - **StarCCM+**



Floor Force Comparisons

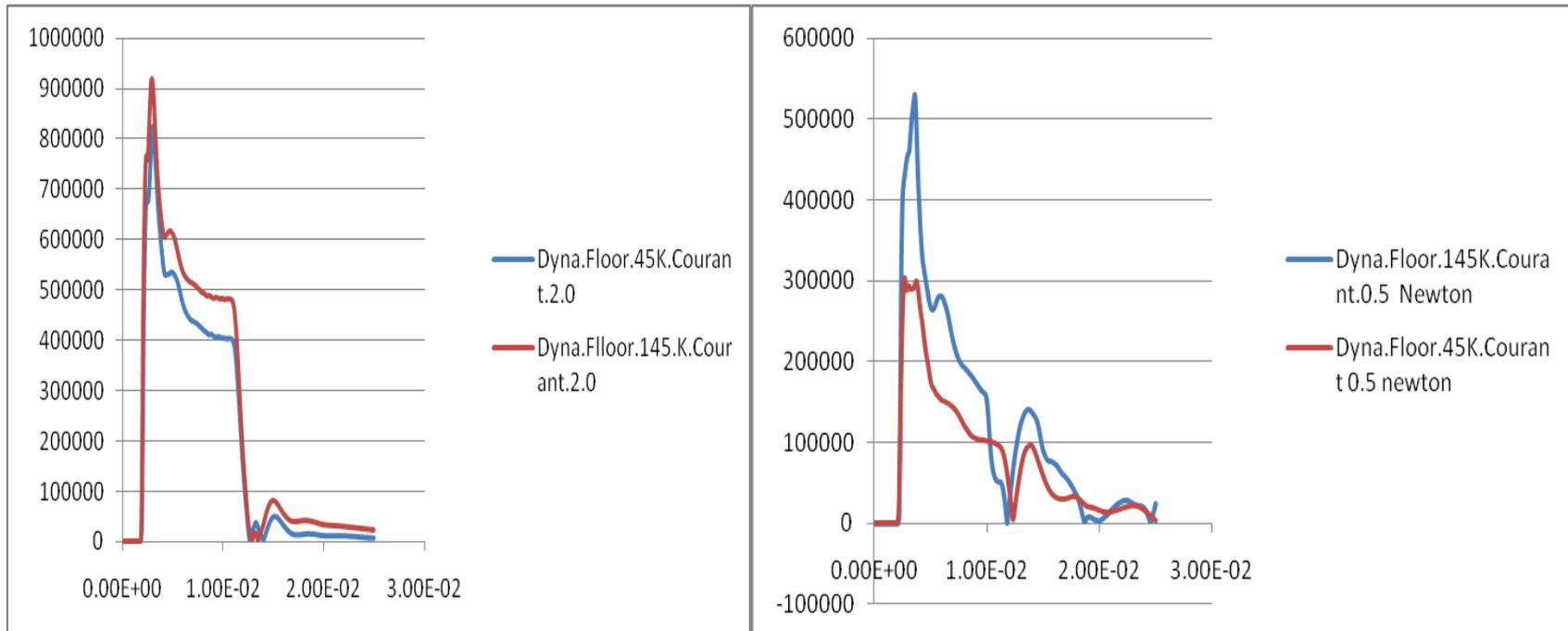


- **Mesh Density Study:**

- **LS-DYNA**

Courant = 2.0

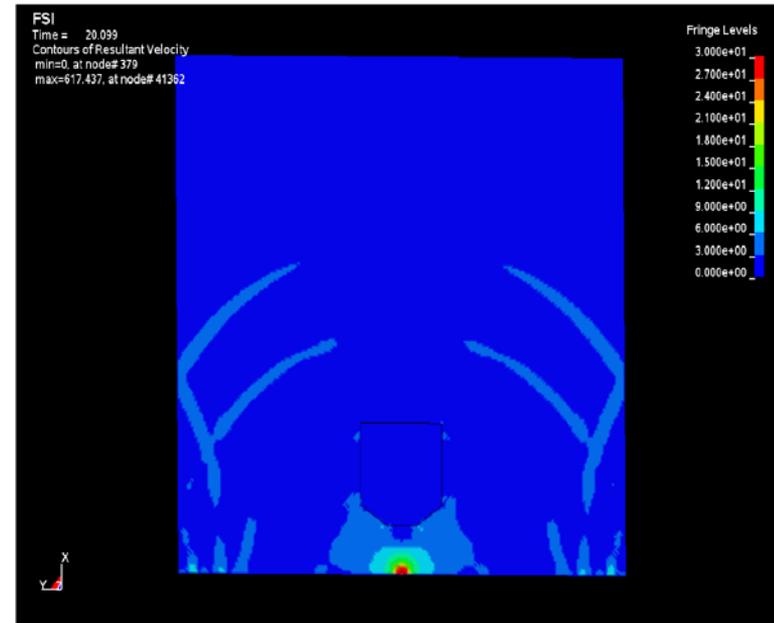
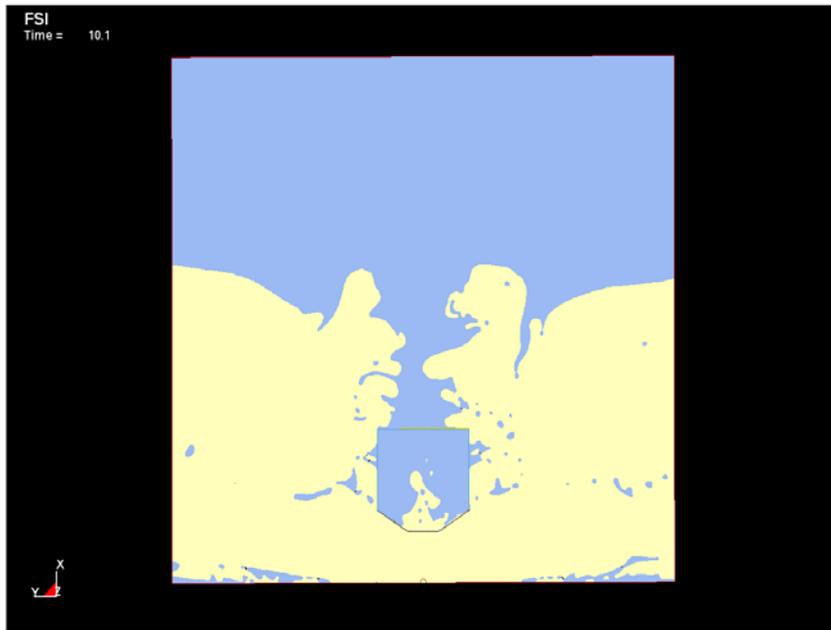
Courant = 0.5



Floor Force Comparisons



- **Full FSI Analysis:**
Conducted only with LS-DYNA



Flow interaction with the structure



- Full FSI Analysis :

LS-DYNA computation





Possible Future Direction:

- ***Investigate Blast Analysis in different Media (Water/ soil)***
- ***Compare Other FSI software against the current one***
- ***Import Pressure from STARCCM+ as a 1-way Couple to LS-DYNA***



Conclusion:

Several possibilities have been investigated that include studies with Courant number setting, Supersonic Static Pressure setting that shows Finite Volume and Finite Element results can be equivalent

The Effect of Mesh Density on Force prediction has been demonstrated

A 2-D type of analysis has been demonstrated to mimic that of a full 3-D analysis and are effective for what-if scenarios