

Effects of a rigid foam on a barrier breach due to explosive loading

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Reason for analysis

- Determine the effects of rigid foam in a barrier structure
- Purpose of barrier structure is to keep the high pressure from the rapid expansion of gases out as long as possible during explosive loading
- There are constraints that bind the design e.g. weight, material, thermal properties

Tool For Analysis

- CTH-Sandia developed Eulerian shock physics analysis package, aka hydrocode
 - Most widely used package in the country
 - Mesh description-AMR
 - Plotting tools-K2
- Foam was modeled by using the Sesame Table with the P-Alpha model
 - Simulates the pore compaction for initially porous materials

Crawford, D.A., Brundage, A.L., Harstad, E.N., Ruggirello, K., Schmitt, R.G., Schumacher, S.C., Simmons, J.S., 2013. CTH User's Manual and Input Instructions, Version 10.3

Barrier structure

- Two plates of 17-4 hardened stainless steel
- Outer plate - 18 ga. (0.050 in)
- Inner plate - 22 ga. (0.032 in)
- Foam - 3lb rigid polyurethane 1 in. thick

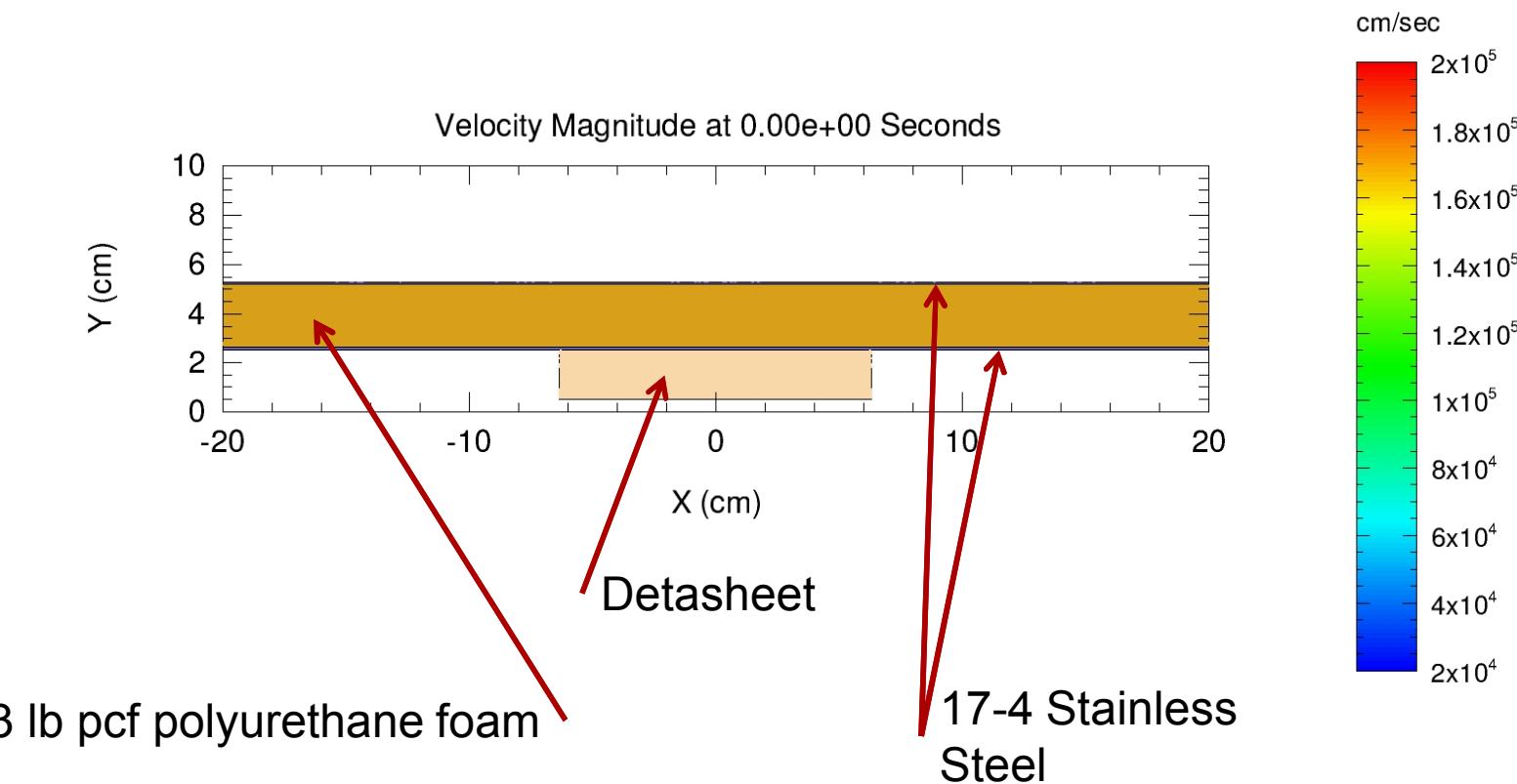
Purpose of Foam

- Purpose of foam between barrier panels
 - Thermal properties
 - Thermal properties to resist in rapid temperature changes through the barrier structure
 - Fire retardant
 - The foam reacts with the fire and self-extinguishes.
 - As the foam extinguishes, it fills in voids and cracks to prevent oxygen from entering barrier structure

Pagni, Alan G., 2013. Pour in Place Polyurethane Foam Performance as an Impact Mitigation and Flame Retardant Material Used in Nuclear Material Transportation Containers – The Mechanism of Intumescence

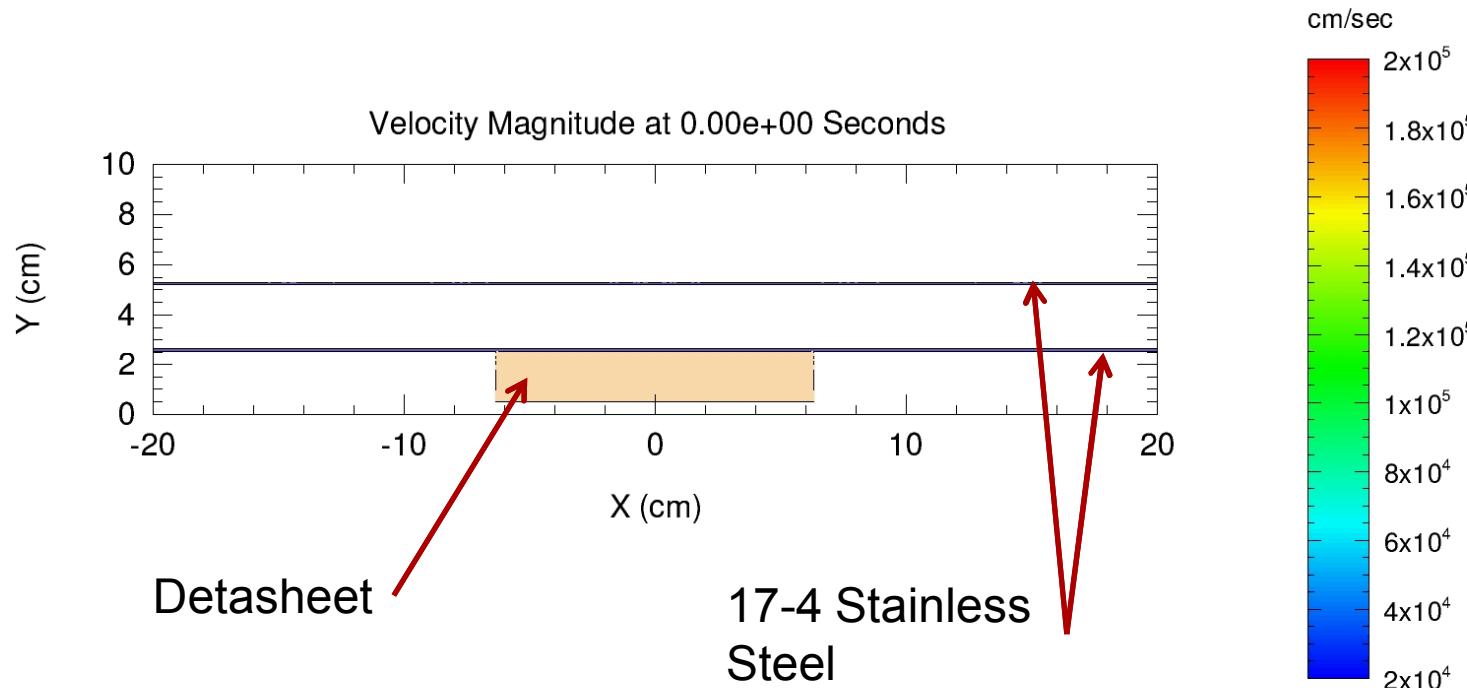
Barrier panel with foam

- CTH Model



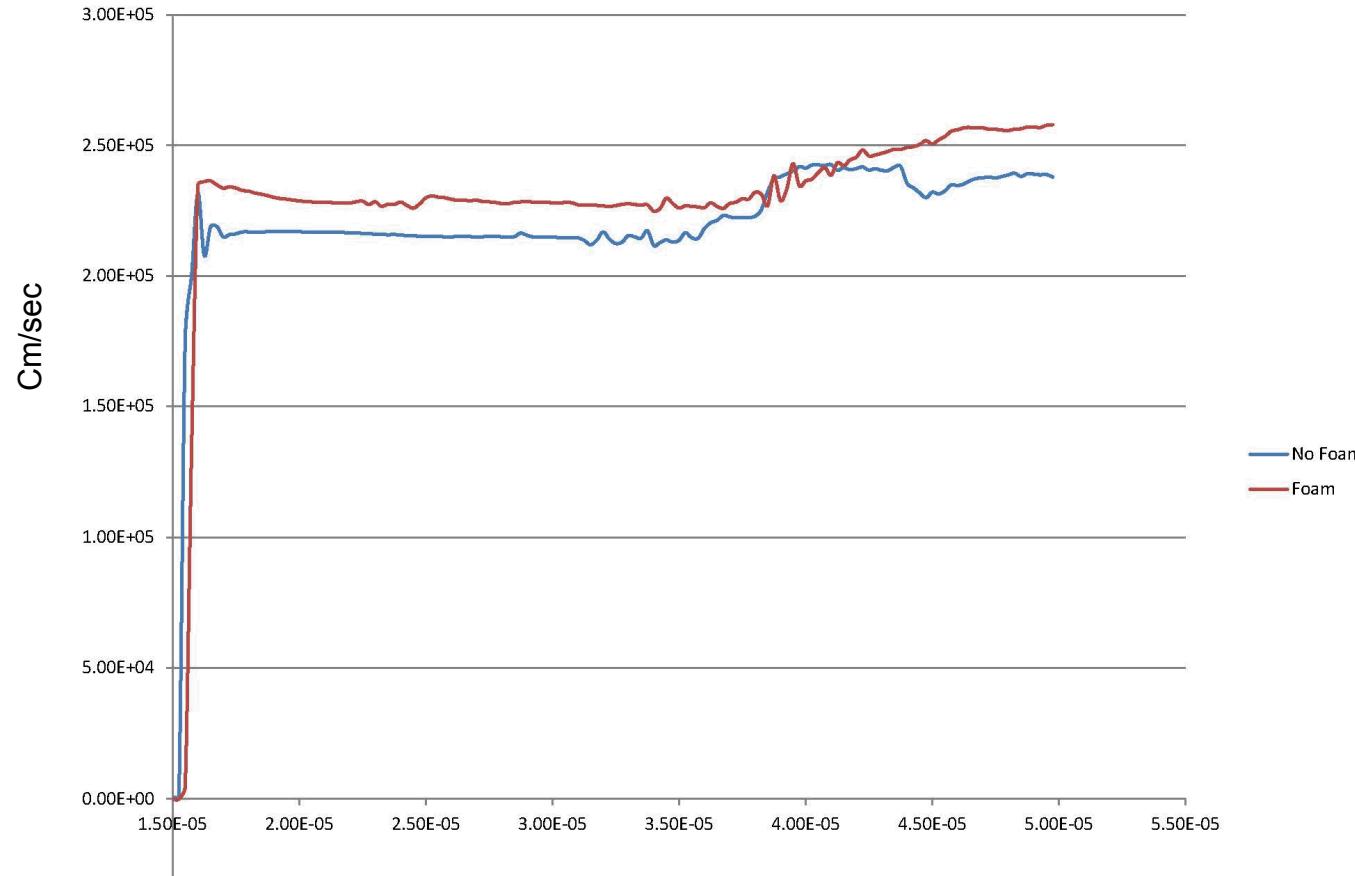
Barrier Panel without rigid foam

- CTH Model



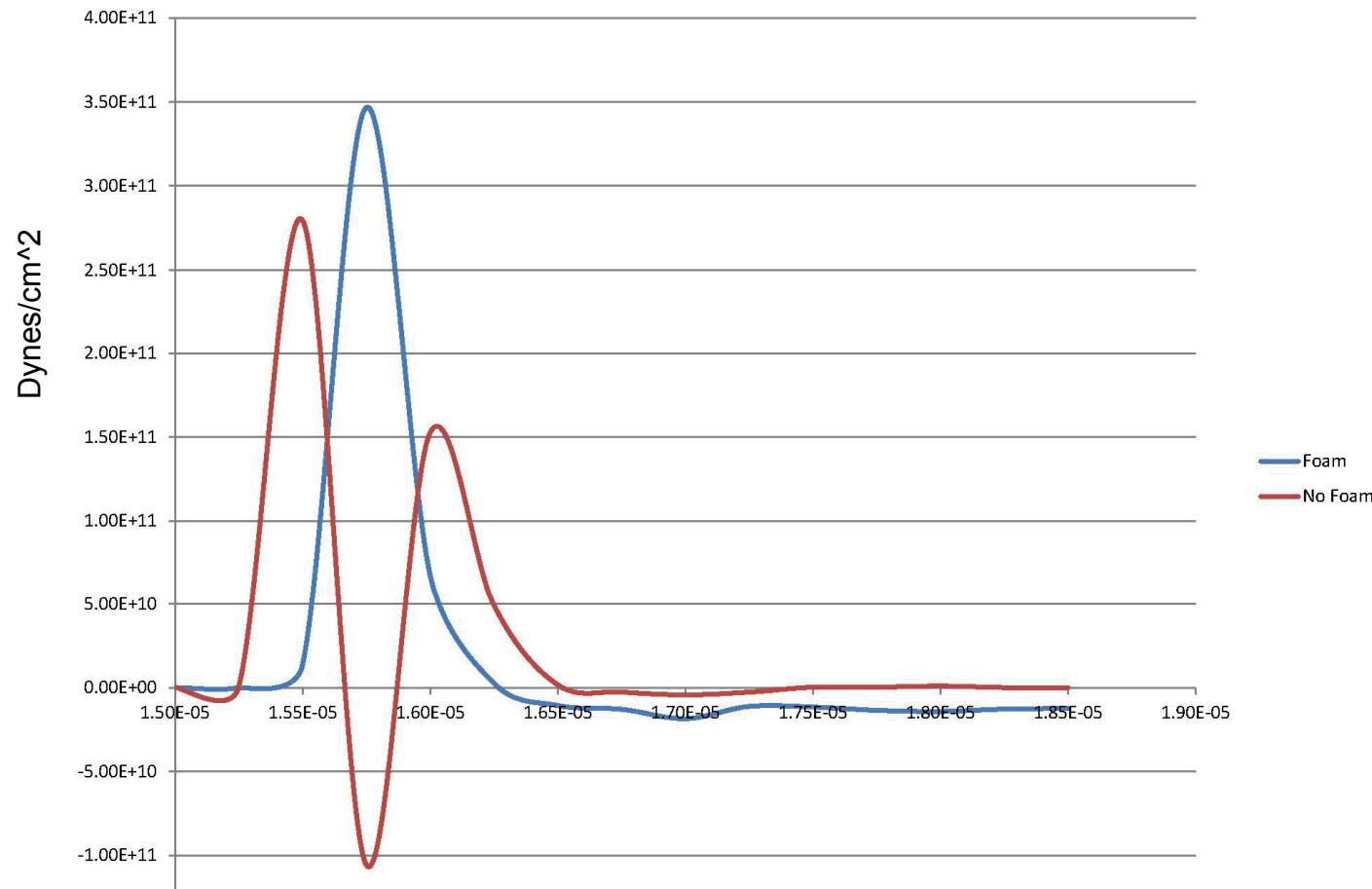
Comparison of barrier panel

- Velocity data from analysis



Comparison of barrier panel

- Pressure data from analysis



Conclusion

- The analysis does point to the foam inside the barrier panel does keep the pressure out longer than the barrier without the foam
- There is some concern about the higher pressures with the foam barrier
- The barrier without foam needs more attention to verify the data is correct
- The velocity of the inner panel on both barrier systems are comparable

Follow on work

- Follow on analysis
 - Optimize materials for barrier section
 - More ductile stainless steel
 - Different density of foam
 - Vary thickness of foam
 - Compare modeling to Presto

Questions