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THE ROLE OF RAYLEIGH TAYLOR INSTABILITY IN SHAPED CHARGE JETS FORMATION AND STABILITY

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17th International Symposium on Ballistics, Midrand, South Africa, 23-27 March 1998

ABOUT VARYING SHAPED CHARGE LINER THICKNESS

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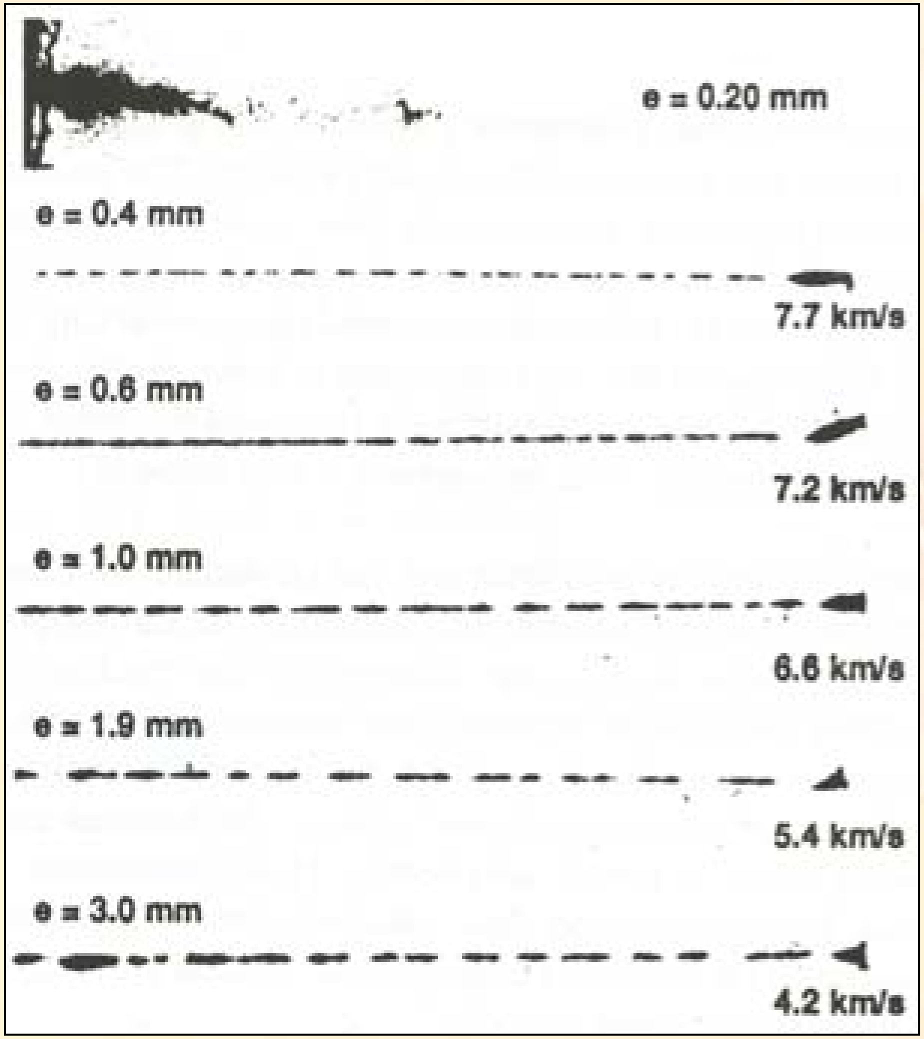
The influence of linear wall thickness on shaped charged jet behavior is investigated. X-ray pictures are presented of jets from 60° copper liners with thickness ranging from 0.4% to 7% of the charge diameter. **First, it is shown that under a minimal thickness, about 0.25 mm, no compact copper jet is formed.** Then, the influence of liner wall thickness on jet fragmentation is studied and a variation of the characteristic velocity difference between consecutive fragments is reported. Introducing this variation in a 1D-code allows for reproducing the jet fragmentation behavior for the whole range of liner thickness considered.



e = 0.20 mm
e = 0.4 mm
7.7 km/s
e = 0.6 mm
7.2 km/s
e = 1.0 mm
6.6 km/s
e = 1.9 mm
5.4 km/s
e = 3.0 mm
4.2 km/s

Experiments in plate cutting by shaped high explosive charges

By A.I.O. Zaid, J.B. Hawkyard and W. Johnson

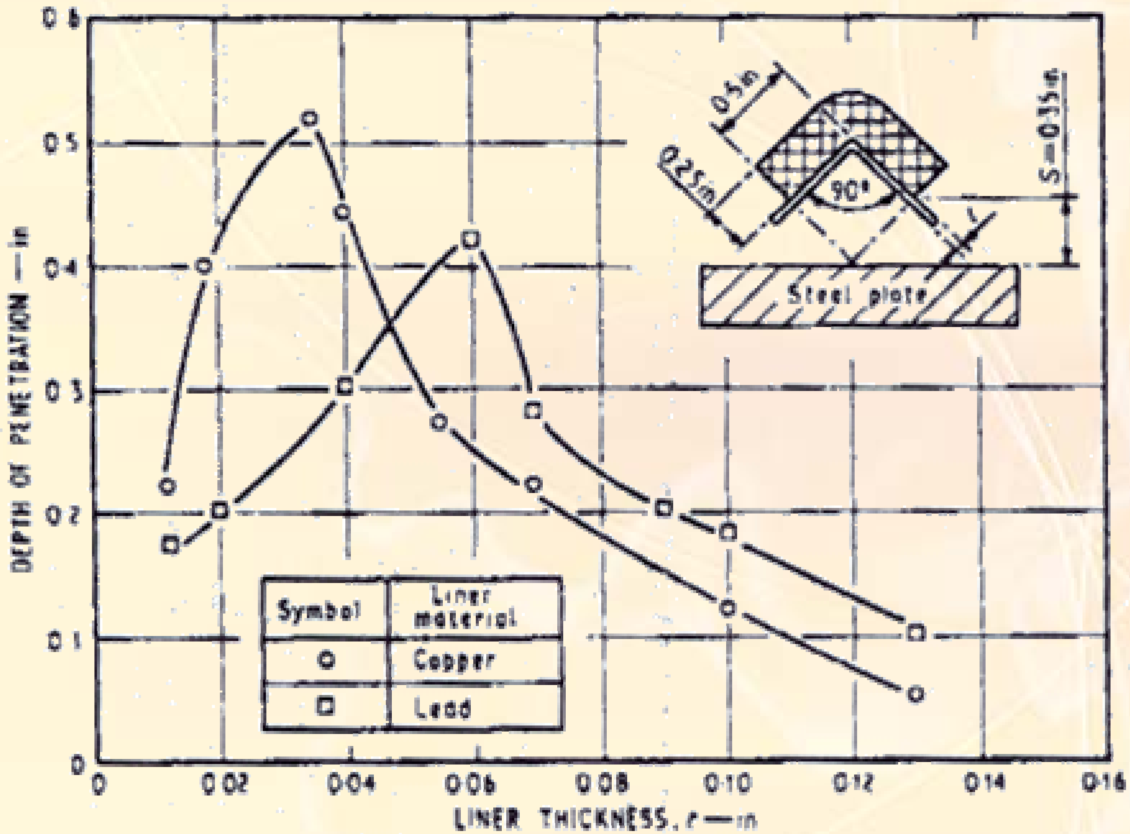


Fig. 8. *Effect of liner thickness on penetration*

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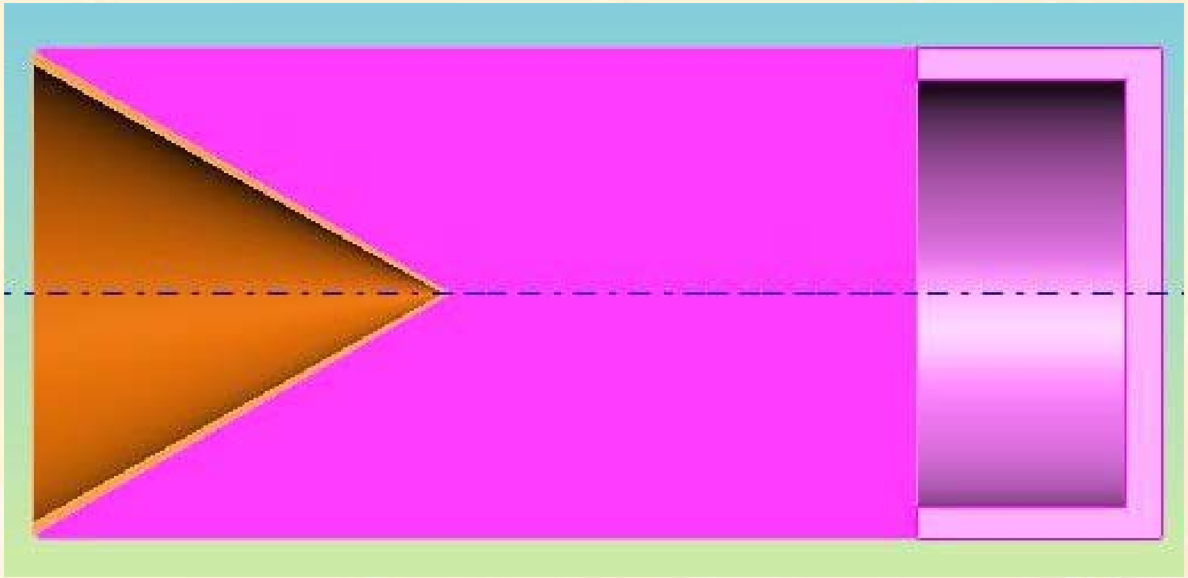
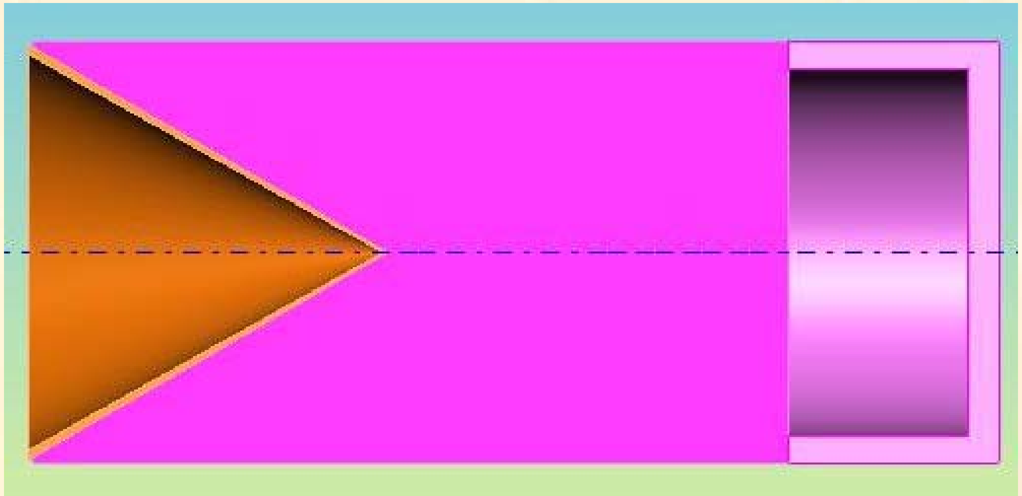
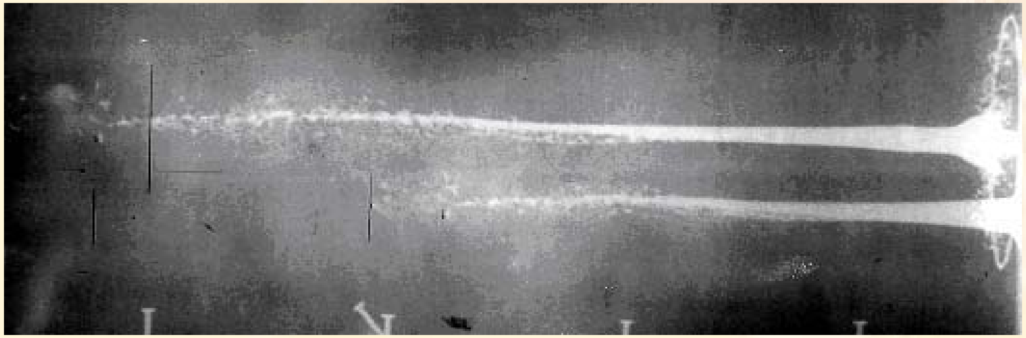
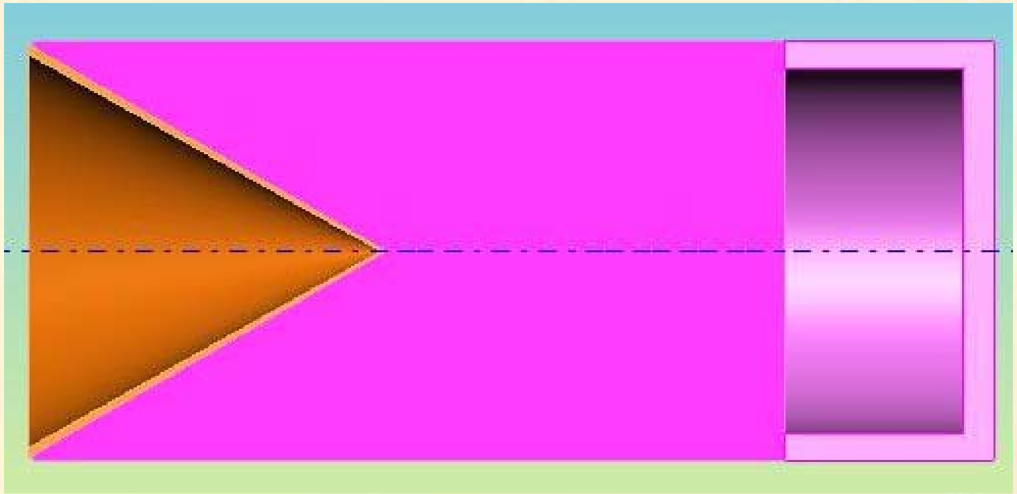


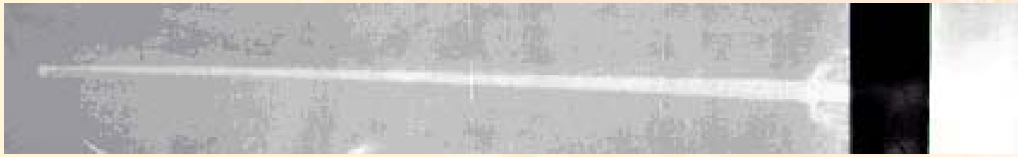
Charge configuration, using high quality explosive PBX – LX07, based on 90% HMX and 10% Viton.



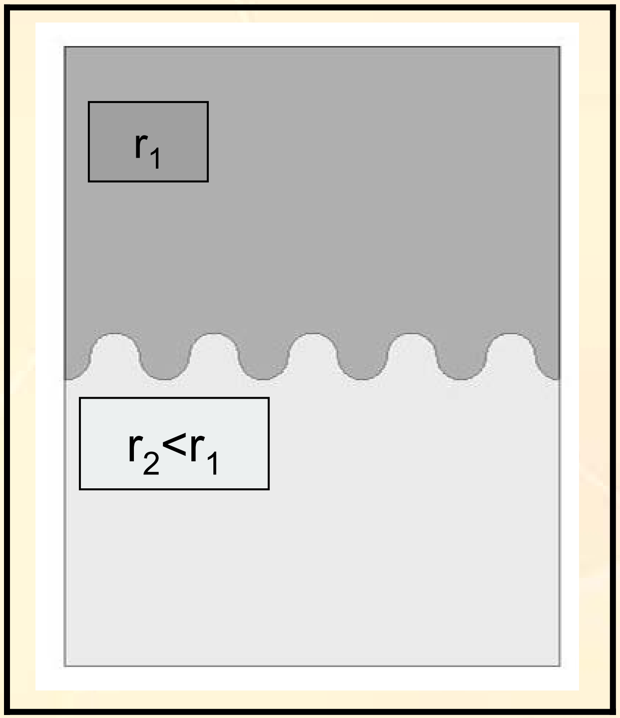


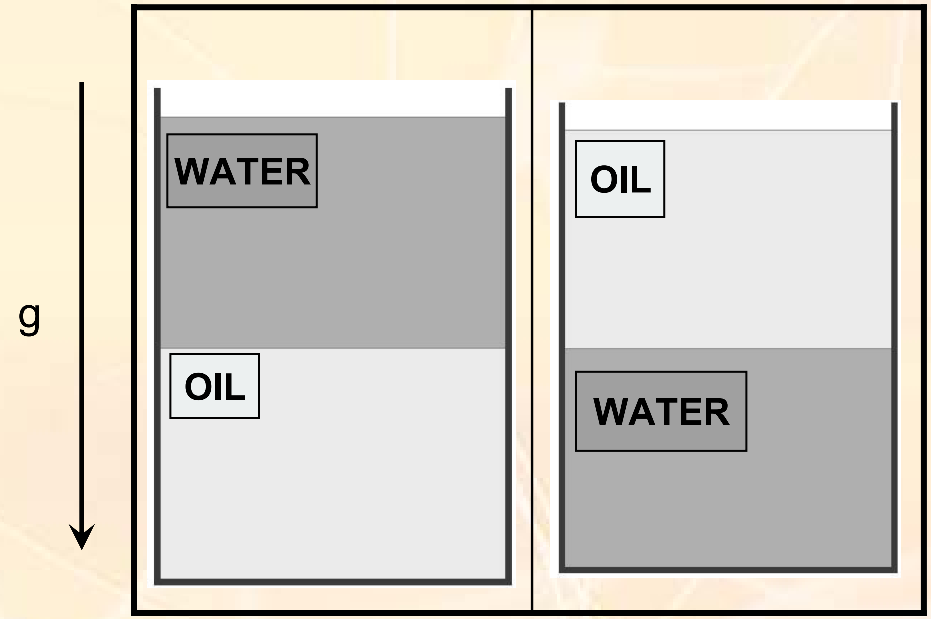
Same charge configuration with different explosives PEX01, based on 93 wt% HMX and siliconic binder and formed by injection molding into a cylindrical shape.
After polymerization (curing) the hollow cone is machined to its final dimension.





Same charge, same explosive PEX01, but this time the charge is formed by direct injection of the explosive on the liner.





$$a = a_0 \exp\left[\left(\frac{2\pi}{\lambda}\frac{\rho_1-\rho_2}{\rho_1+\rho_2}g\right)^{1/2} t\right]$$

Simple demonstration of Rayleigh Taylor Instability

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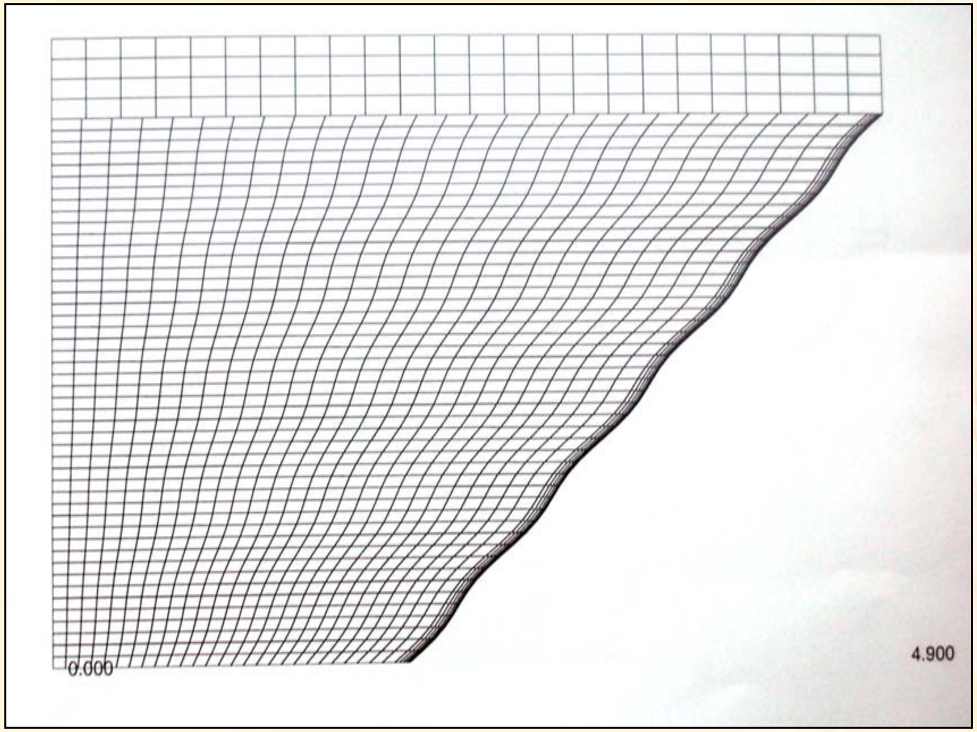
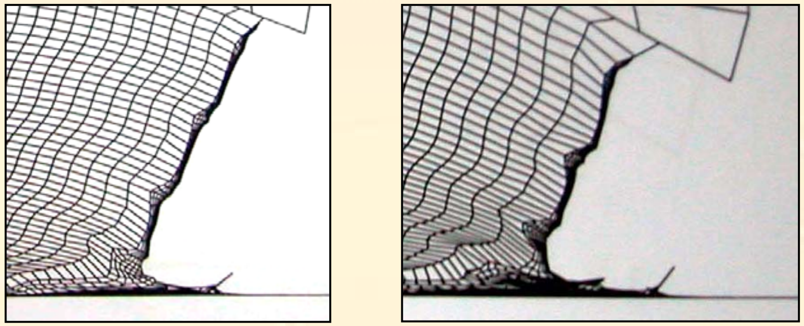
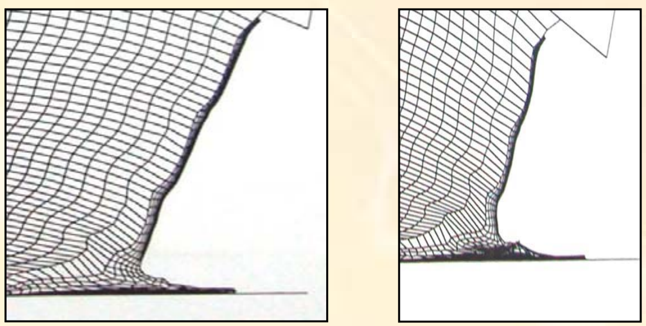
Demonstration of the relevance of the RTI
to shaped charge jet formation.



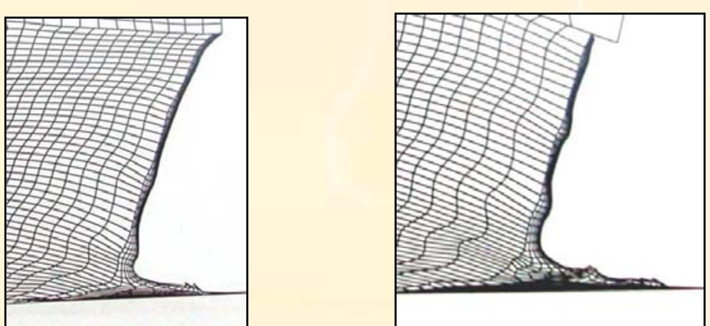
Initial grid setup with a sinusoidal liner.



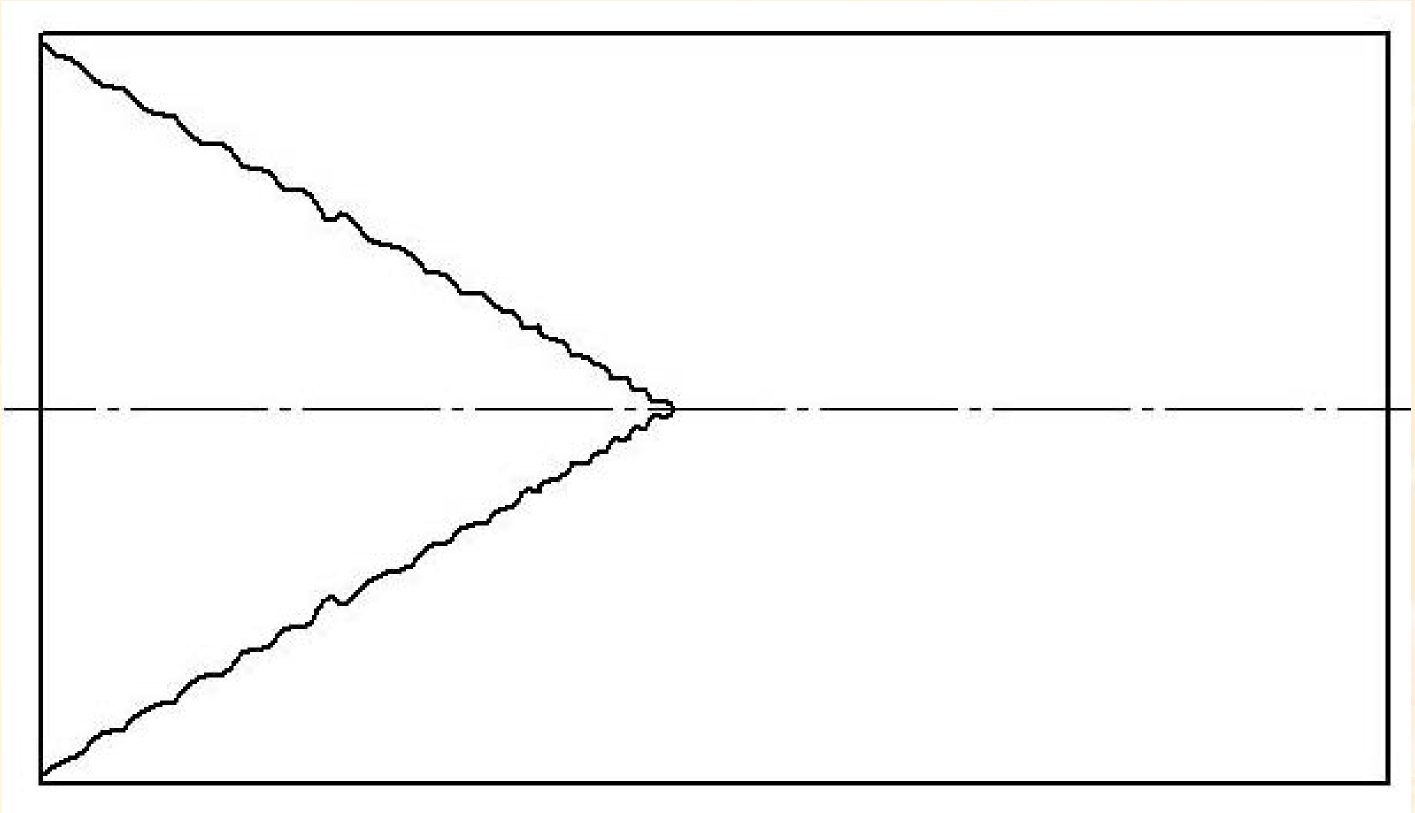
The growth of the initial grid during collapse with a liner made of copper (nominal strength).

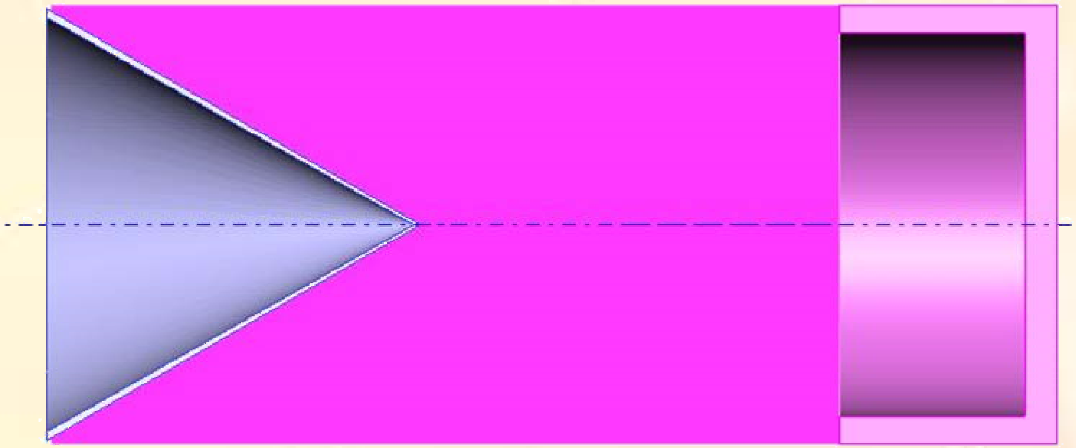


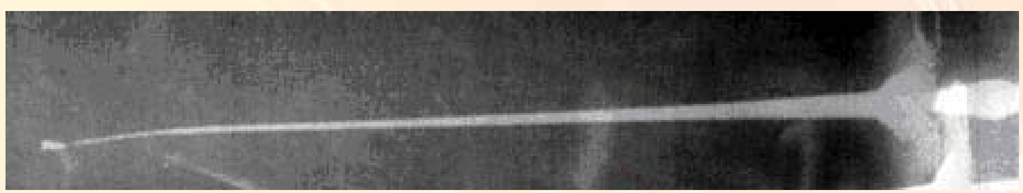
No change in shape during collapse if the simulation is performed with increased strength by a factor of 4.



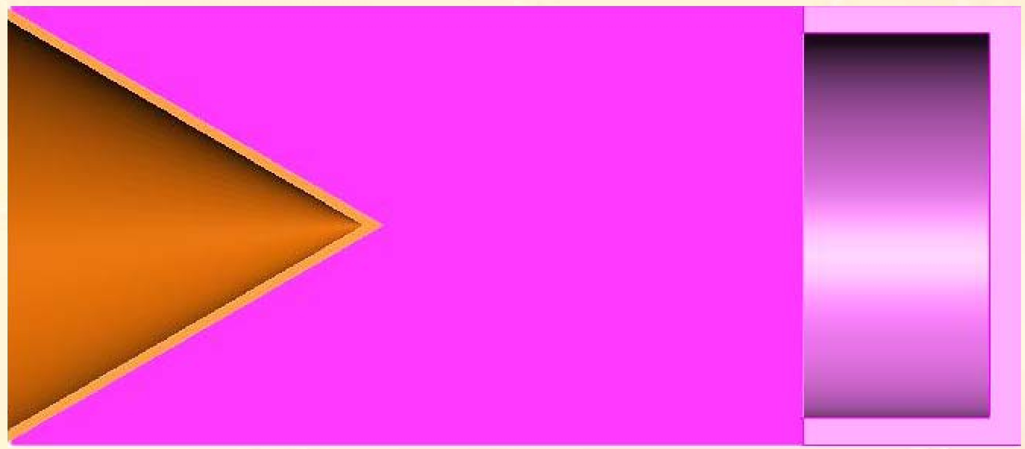
The same initial charge configuration except for the liner. This is the simulation results with aluminum liner (nominal strength). Actually, the interface between the liner and the explosive tends to be smoothed to a straight line.



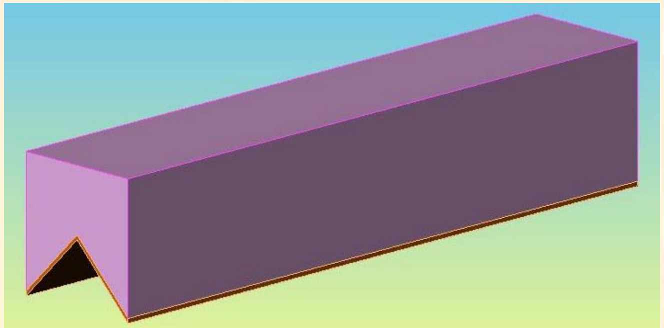




Repeating the experiment with the machined cone in the PEX01 explosives, but with Molybdenum liner.

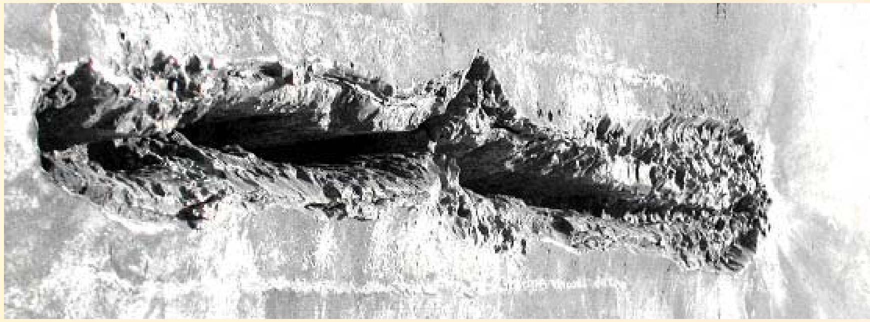



Repeating the experiment with the machined cone in the PEX01 explosives with 2% copper liner.



Schematic description of a linear shaped charge configuration.

The crater opening on aluminum target by a configuration with 3% CW thickness copper liner.



Same as above, but with a variable thickness copper liner from 1% CW near the apex to 3% CW near the base.

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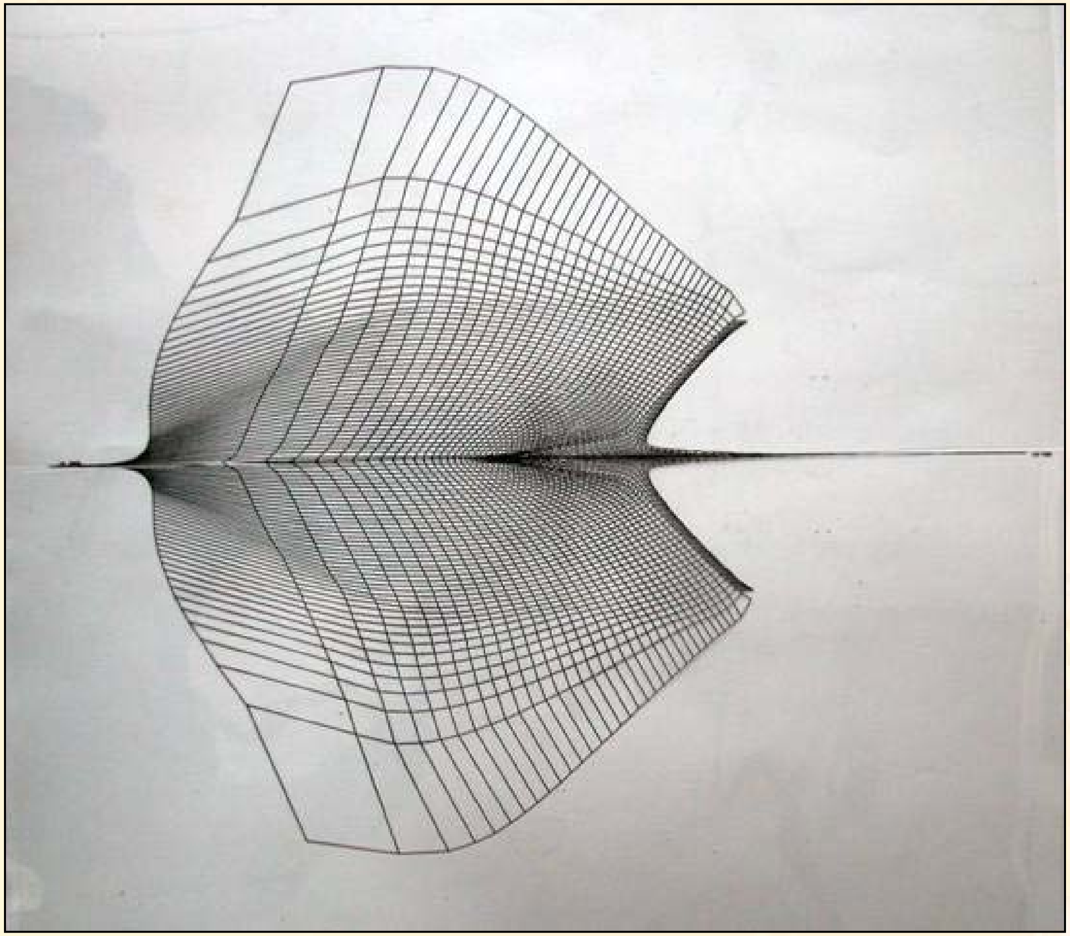
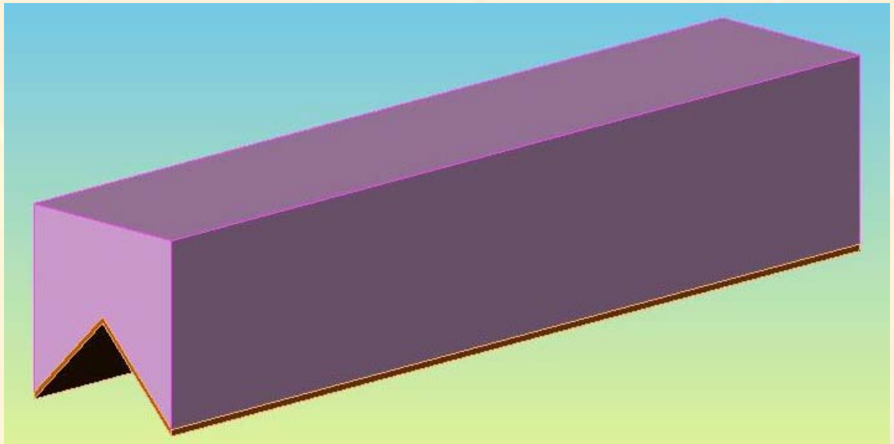


summary

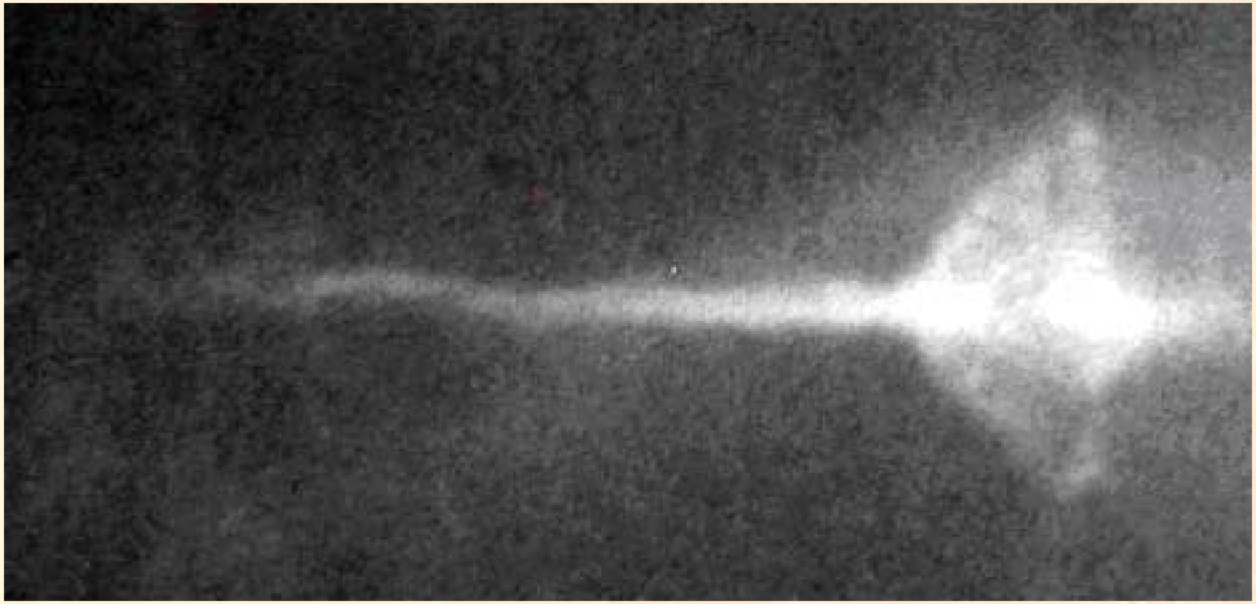
The RTI might have a destructive role in jet formation unless the charge configuration is designed beyond certain threshold limits:

- Minimum liner thickness which depends on liner density and strength.
- Explosive quality, especially near the contact surface with the liner.
- Linear charges experiments have proven to be much more sensitive to initiate instabilities. Some reasonable assumptions have been offered to explain the difference between conical and linear charges. Further investigation is needed in order to gain a conclusive understanding.

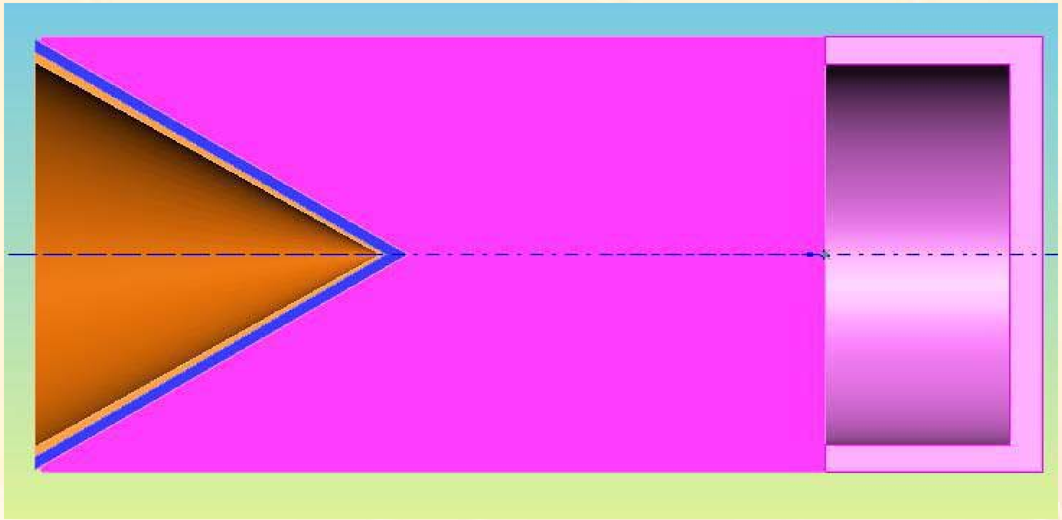


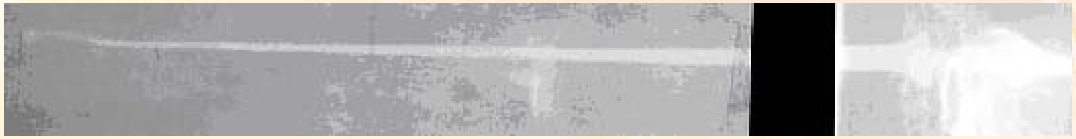
$$a = a_0 \exp\left[\left(\frac{2\pi v\sqrt{\rho_1\rho_2}}{\lambda(\rho_1\rho_2}\right)t\right]$$

$$a = a_0, \, v = \frac{2\pi \Delta U}{\lambda} a_0 \frac{\rho_1 - \rho_2}{\rho_1 + \rho_2}$$



The charged configuration with PBX-LX07 scaled down by factor 6. Liner thickness around 0.08 mm.





Repeating the experiment with the machined cone in the PEX01 explosives, but with a thin layer of lexan (2 mm thick) inserted between the liner and the explosive.

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