Numerical investigations on penetration of target plates by shaped charge jet using the smoothed particle hydrodynamics (SPH) method

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Abstract

Explosion induced perforation including shaped charge jet (SCJ) is widely adopted in military and industrial applications. The SCJ problem involves processes like the detonation of explosive charge, impact of metal structures and strong fluid-structure interaction with complex features such as jetting formation and metal phase-transition. However, the whole SCJ process has not been well modeled and the associated mechanisms are also not well understood due to the large deformation and moving interfaces. In this work, an improved smoothed particle hydrodynamics (SPH) method [1] is employed to model the three-dimensional SCJ problem. As a meshfree and particle method, SPH has natural advantages in treating large material deformations in explosion and impact problems [2]. With the present improved SPH, the whole process of SCJ from detonation of explosive to penetration of target plate can be well modeled, as shown in Figure 1. Furthermore, we simulate various SCJ cases with different explosive charge and cone angle, and study the penetration of target plate while illustrating some important mechanisms. It is demonstrated that with the decrease in cone angle (before reaching a critical value), the charge jet length is longer and its velocity becomes larger. The effective explosive charge [1] in SCJ is also explained where the explosion effect does not significantly increase after the amount (length) of explosive charge reaches a critical value.

Keywords: Smoothed particle hydrodynamics (SPH), shaped charge jet, penetration, dynamic response, effective explosive charge

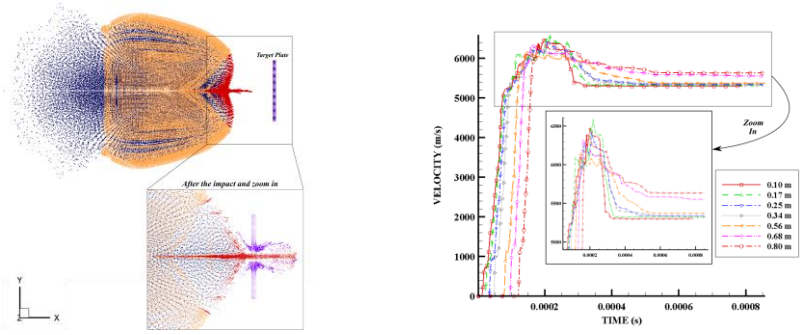

Figure 1. Penetration of target plate by shaped charge jet (left), and distribution of jet velocities for cases with different explosive charges (right)

References

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