An SPH Modeling of Jet Penetration into Underwater Structures

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Abstract: A metal jet can be formed for a shaped charge subjected to air blast, which can cause local damage on structures. As for the high-velocity jet associated with underwater explosion, a high-pressure shock wave and a long-term bubble can be also generated. Underwater structures can be severely damaged by these three loadings. A Smooth Particle Hydrodynamic (SPH) method has advantages of solving problems of large deformations thanks to its mesh-free Lagrange formulation. Therefore, it is applied to simulate an entire process of a metal-jet penetration into underwater structures. First, a verification of near-field underwater explosion was carried out. The obtained numerical results were compared with the experimental data in order to verify the effectiveness and accuracy of the presented SPH method. Second, an SPH model of a shaped-charge jet associated with near-field underwater explosion penetration into underwater structures was developed. The propagation of shock waves in multi-media and the process of the jet formation were analyzed. Third, damage characteristics of underwater structures were investigated. Finally, the effect of standoff distance between the charge and the structure was discussed. The obtained results show that a large deformation of the structure can be caused by the shock wave with high pressure while a hole can be generated after the jet penetration. The standoff distance has a great effect on damage characteristics of the structures subjected to the jet associated with underwater explosion.

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