Numerical method for underwater explosion loads and the associated structure damage

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Abstract

The underwater explosion can produce shock wave load and bubble load. The shock wave is of a high peak pressure and a fast transmit, which lasts about several milliseconds; while the bubble load has a relatively low peak pressure, which lasts about a few hundred milliseconds or even reaches second order. It brings a big challenge to traditional numerical methods to calculate shock wave load and bubble load simutaneously. Therefore, according to the load characteristics of shock wave and explosion bubble, a combined numerical method is adopted in this paper. Based on compressible fluid dynamics theory, Smoothed Particle Hydrodynamics (SPH) method is used to simulate the shock wave transmit and to calculate the shock wave load; the Boundary Element Method is used to simulate the bubble motion and to calculate the corresponding pressure load. On this basis, finite element method is adopted to calculate the structure deformation, and 'loose coupling' and 'full coupling' algorithms are proposed, respectively. In this paper, the underwater explosion load and the relevent transient fluid-structure coupling effect are simulated using the above numerical methods, and dynamic responses of underwater structure under shock wave load and bubble load are calculated. This study aims to provide numerical model and method for structure damage caused by underwater explosion.