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Numerical Predictions of Trajectory Stability of a High-Speed Water-Entry and Water-Exit Projectile

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Abstract : In this study, a detailed analysis of trajectory stability and flow characteristics of a high-speed projectile during the water-entry and water-exit process has been investigated numerically. The Zwart-Gerber-Belamri (Z-G-B) cavitation model and the SST k-ω turbulence model based on the Reynolds Averaged Navier-Stokes (RANS) method are employed. The numerical methodology is validated by comparing the experimental photograph of cavitation shape and the experimental underwater velocity with the numerical simulation results. Based on the numerical methodology, the influences of rotational speed, water-entry and water-exit angle of the projectile on the trajectory stability and flow characteristics have been carried out in detail. The variation features of projectile trajectory and total resistance have been conducted, respectively. In addition, the cavitation characteristics of water-entry and water-exit have been presented and analyzed. Results show that it may not be applicable for the water-entry and water-exit to achieve the projectile stability through the rotation of projectile. Furthermore, there ought to be a critical water-entry angle for the water-entry stability of practical projectile. The impact of water-exit angle on the trajectory stability and cavity phenomenon is not as remarkable as that of the water-entry angle.

Keywords : cavitation characteristics, high-speed projectile, numerical predictions, trajectory stability, water-entry, water-exit
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