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Cavity Dynamics in Vertical Water Entry of a Body at Low Froude Numbers HONGMEI YAN, YUMING LIU, Center for Ocean Engineering, Department of Mechanical Engineering,MIT — The dynamics of a cavity induced by the vertical water entry of a three-dimensional rigid body is investigated both theoretically and computationally. The study is focused in the relatively low Froude number range, i.e. $F_r \equiv V(gD)^{-1/2} = 1 \sim 10$ (V is the dropping velocity of the body, D characteristic length of the body, and g the gravitational acceleration), when the surface closure is preceded by deep closure of the cavity. To understand the basic mechanism for the formation and collapse of cavity, an asymptotic theory is developed based on the slender-body assumption. Direct comparisons with existing experimental data (for disks and spheres) show that the theory properly captures the key physical effects involved and gives a satisfactory prediction on the cavity height and closure time, but is incapable of accurately accounting for the effects associated with the details of the body geometry. To complement the theory, a complete numerical model is developed based on fully nonlinear computations using the boundary integral equation method. Both theoretical and numerical solutions for the dependence of cavity height and closure time on Froude number and body geometry are obtained and compared with available experiments. This study is of importance to the understanding of the mechanics of (small) animal walking on water surface and to the design of projectiles.

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