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PROPERTIES OF NATURAL CAVITATION FLOWS AROUND A 2-D WEDGE IN SHALLOW WATER*

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Abstract: When a body navigates with cavity in shallow water, both flexible free surface and rigid bottom wall will produce great influences on the cavity shape and hydrodynamic performances, and further affect the motion attitude and stability of the body. In the present work, characteristics of the natural cavitating flow around a 2-D symmetrical wedge in shallow water were investigated and the influences of two type boundaries on the flow pattern were analyzed. The Volume Of Fluid (VOF) multiphase flow method which is suitable for free surface problems was utilized, coupled with a natural cavitation model to deal with the mass-transfer process between liquid and vapor phases. Within the range of the cavitation number for computation (0.07-1.81), the cavity configurations would be divided into three types, viz., stable type, transition type and wake-vortex type. In this article, the shapes of the free surface and the cavity surface, and the hydrodynamic performance of the wedge were discussed under the conditions of relatively small cavitation number (< 0.256). The present numerical cavity lengths generally accord with experimental data. When the cavitation number was decreased, the cavity was found to become longer and thicker, and the scope of the deformation of the free surface also gradually extends. The free surface and the upper cavity surface correspond fairly to their shapes. However, the lower side of the cavity surface was rather leveled due to the influence of wall boundary. The lift and drag coefficients of this 2-D wedge basically keep linear relations with the natural cavitation number smaller than 0.157, whereas direct proportion for drag and inverse proportion for lift.

Key words: shallow water, natural cavitation, boundary effect, multiphase flow

Introduction

When a high-speed underwater vehicle encapsulated in cavity navigates in shallow water, like offshore area, both the flexible free surface and the rigid water bottom will produce obvious influence on the cavity shape and the hydrodynamic performance of the vehicle. In such case, the so called "boundary effect" will make the flow blocked and affect the motion attitude and stability of the vehicle.

Regarding the boundary effect problems caused by solid wall, many researches have been conducted so far in the world through the approaches of theoretical analysis, numerical simulation and experimental investigation. Zhou et al.[1] numerically studied the difference between water tunnel experiments and infinite flow field, including the influence of the route loss and the blocking effect in a water tunnel. They claimed that the wall of the water tunnel should be smoothed to reduce not only the blocking effect but also the pressure drop as far as possible. Chen et al.[2] utilized the multiphase model based on the RANS equations to numerically analyze the wall effect on ventilated cavitating flows around a kind of under-

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