Evolution of Vortex Structures and Bubble distributions in Cloud Cavitation

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Long Abstract

Introduction

The aim of this study is to explore the vortex flow structure in cloud cavitation in details. Some recent experimental results with high-speed camera observations of cloud cavitation in three dimensional twisted hydrofoils were reported, while numerical simulations by LES method were used to further understand the development of vortex strength in the evolution of cloud cavitation. The clear vortex flow structures were observed both in experiments and in numerical simulations. The results showed the velocity circulation including reentrant flows around the attached cavity control the evolution of could cavitation, which is the course of the formation of U-shaped vortex structures in could cavitation. The bubble distributions in the cloud cavitation were measured by Interferometric Laser Imaging method for different stages of cloud cavitation evolution.

1. Vortex structures in cloud cavitation

NACA16012 twisted hydrofoil was used as model studied both by experiments and numerical simulation. The experiment was conducted in cavitation mechanism tunnel located in China Ship Scientific Research Center (CSSRC). As one example of the results, Figure 1 clearly indicate that the U-shaped vortex flow structure in cloud cavitation shed from the sheet cavitation.

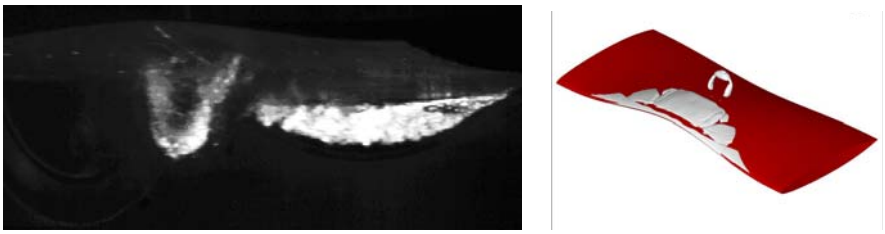

Figure 1. U-shaped vortex structures obtained by experiment (left) and numerical simulation (right)

2. Evlution of vortex strctures

The process of the formation and evlution of vortex flow structures in cloud cavitation was got from high-speed camera observation as shown in Figure 2. To estimate the vortex strength of the U-shaped vortex structure numerical simulation was used to calculate the velocity circulation around the U-shaped vortex section in the middle span as shown in Figure 3. It can be seen that the vortex strength of U-shaped flow structure become descrease with moving to downstream, which matches with the experimental observation qualitatively.

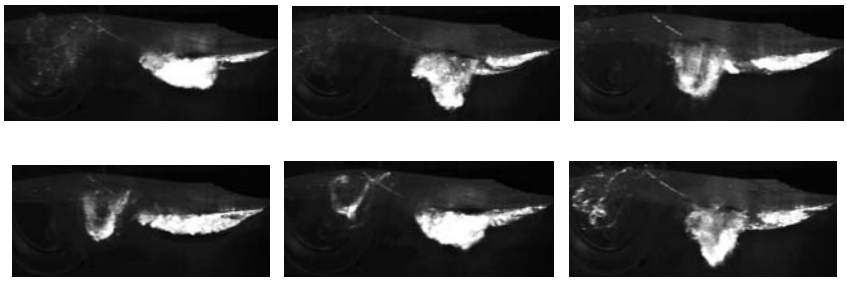

Figure 2. The formation and evolution of vortex flow structures by HSC

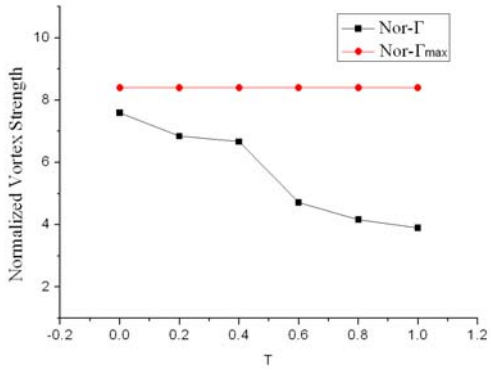

Figure 3. Vortex strength variation of vortex flow structure by CFD

3. Bubble distributions in cloud cavitation

The bubble distributions during the evlution of cloud cavitation were measured by interferometric laser imaging. The fundamental principle of the measurement is that when the laser sheet goes through the bubble in water the interference pattern is formed by scattering lights of incident light on the bubble surface. The circular image with fringes can be obtained on the defocused plane of camera. Then the number and diameters of bubble can be obtained by the number of circular images and fringes respectively in the each bubble images. Figure. 4 give one measurement result which shown the bubble distributions in three different stages during the devolpment of cloud cavitation.

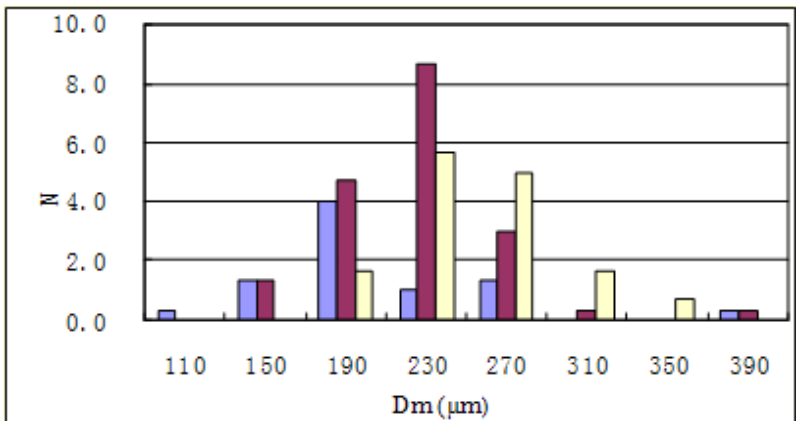

Figure 4. Bubble distributions in three stages of evolution in cloud cavitation

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