Available online at www.sciencedirect.com
ScienceDirect
Journal of Hydrodynamics
2011,23(3):348-352
DOI: 10.1016/S1001-6058(10)60122-9
www.sciencedirect.com/science/journal/10016058

EXPERIMENTAL INVESTIGATION OF CAVITATION IN A SUDDEN EXPANSION PIPE*

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(Received October 25, 2010, Revised March 27, 2011)

Abstract: For sudden expansion pipes, experiments were carried out to study the cavitation inception for various enlargement ratios in high speed flows. The flow velocity of the prototype reaches 50 m/s in laboratory. The relationship between the expansion ratio and the incipient cavitation number is obtained. The scale and velocity effects are revealed. It is shown that Keller's revised formula should be modified to calculate the incipient cavitation number when the forecasted velocity of the flows in the prototype exceeds the experimental velocity.

Key words: high speed flows, sudden expansion pipe, cavitation incipient, scale effect

Introduction

In liquid flows, cavitation generally occurs if the pressure in certain locations drops below the vapor pressure and consequently the negative pressures are relieved by forming cavities filled with gas and vapor. Cavitation can be observed in a wide variety of hydraulic projects[1,2], and it is well known that cavitation flow is usually related with a lot of unpleasant results. In the area of hydropower engineering and hydromachine, studies were carried out to understand the essence of cavitation with the aim to treat it reasonably and properly[3,4].

In these studies, the most important issue is the incipient cavitation, because when the cavitation number of the flow is less than the incipient cavitation number, the flow will become the cavitation flow with various unexpected damages. The incipient cavitation occurs within the region of the separated flow, and the point of the laminar separation and the leading edge of the cavity are closely correlated. Keller[5-7] obtained an experiential but very useful formula for the cavitation inception and pointed out the influence of the scale of velocity. Ni[8] also proposed a similar formula based on the air bubble dynamics and pointed out that there exists the effect of the scale and the velocity for the cavitation inception. Yang[9,10] obtained similar results from a series of tests. All these studies show that the scale effect exists and should not be ignored. However, the general methods to study the incipient cavitation number are mainly by the means of experiments in water tunnel or in depression tank, and thus the scale effect needs to be properly included to predict the flow behavior in prototype projects. Dong et al.[11] investigated the aerated behaviors in the cavitation region of high velocity flows through the non-circulating water tunnel by using the advanced experimental facilities, they proposed relations between the smallest air concentration without the cavitation erosion and the flow velocity and compared the cavitation numbers with and without aeration in the cavitation region. Han et al.[12] studied the cavitation structures of semi-cylindrical irregularity by using high speed photography, and revealed the cavitation structures of semi-cylindrical irregularity and the interaction between aeration bubbles and

* Project supported by the National Key Basic Research and Development Program of China (973 Program, Grant No. 2007CB714105), the National Science and Technology Pillar Program of China (Grant No. 2008BAB29B04), the Science Foundation of Ministry of Education of China (Grant No. 2008108111) and the Program for New Century Excellent Talents in University (Grant No. NCET-08-0378).
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