Experimental Investigation of Ventilated Cavity Flow over a Wall Mounted Fence

Long Abstract

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Introduction

An experimental study of ventilated cavity flow over a wall mounted fence is reported. The cavity is formed when sufficient flux of incondensable gas is injected in the wake region of the liquid flow. The introduction of the gas promotes the formation of large gaseous cavities that may benefit many flows in maritime engineering applications. These include drag reduction of the cavitating object and enhanced flow stability.

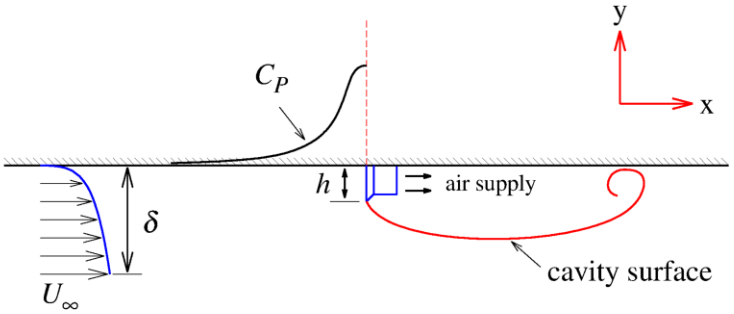

Figure 1. Schematic showing wall mounted fence immersed in the test section ceiling boundary layer with a ventilated cavity detaching from the sharp outer edge. Air is supplied through a manifold on the downstream face of the fence.

1. Methods

Experiments were performed in the water tunnel in the University of Tasmania Cavitation Research Laboratory. The tunnel has ancillary systems for rapid degassing and continuous separation of large volumes of injected incondensable gas. Two fences have been built from stainless steel to perform 2D and 3D tests. The 3D fence spans a quarter of the width of the test section. Fences have been machined with the sharp tip to enable smooth cavity detachment. Air injection manifolds have been built integral with the fence in stainless steel with equi-spaced gas passages on the fence downstream face. The fence was mounted on a six-component force balance, or on an acrylic ceiling window, depending on the type of measurement. The experimental setup has been developed to investigate the effect of injected gas (air) flux on the cavitation number and drag on the fence. The fence was tested at the two streamwise positions on the test section ceiling to investigate the effect of varying boundary layer immersion on the cavitation number and drag. Thicker boundary layers were achieved using artificial thickening via injection of an array of transverse jets. Upstream wall pressure distribution was measured using pressure tapings distributed along the ceiling. The lift was calculated as the integral value of the pressure distribution along the upstream wall. The influence of each of the independent parameters on the cavity topology has been investigated using still and high-speed photography. All experiments were carried out for a fixed fence height based Reynolds number and for the three values of the vapor pressure based freestream cavitation number. Additional experimental data for natural cavity cases has been obtained for comparison.

2. Results

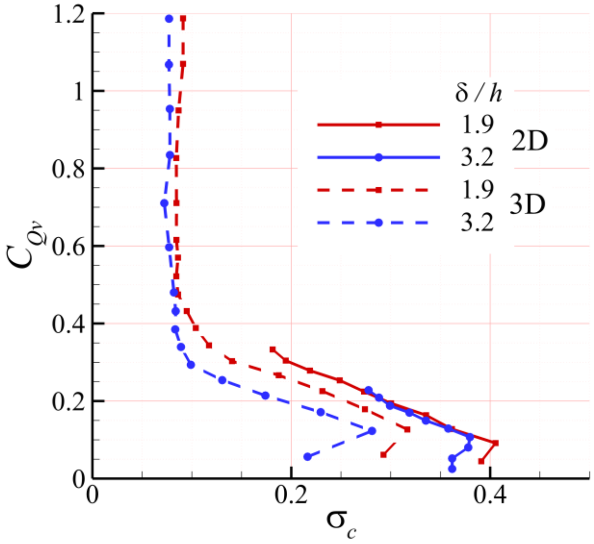

Figure 2: Cavitation number (σ_c) variation with air volumetric flowrate coefficient (C_{Qv}) for two boundary layer thickness to fence height ratios (δ/*h*), for 2D and 3D cases with fixed Reynolds number and free-stream cavitation number.

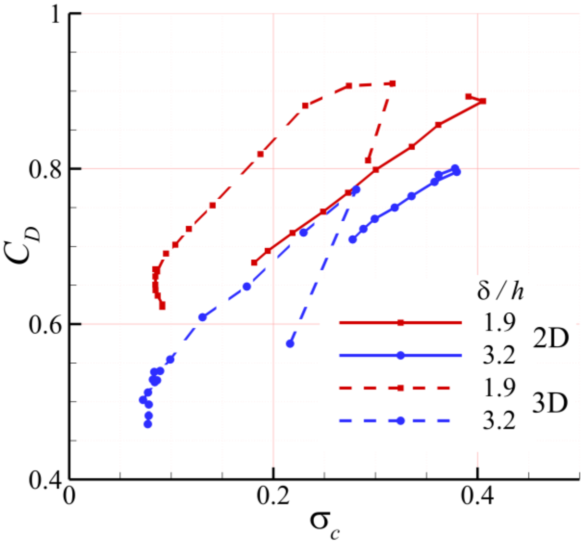

Figure 3: Drag coefficient (C_D) variation with the cavitation number (σ_c) for two boundary layer thickness to fence height ratios (δ/*h*) for the 2D and 3D cases at fixed Reynolds number and vapor pressure based free-stream cavitation number.