FLOW STRUCTURES AND EXCITATION CHARACTERISTICS OF THE IN A STAGGERED FLAT PLATE CASCADE AT DIFFERENT REYNOLDS NUMBER

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Long Abstract

Introduction

Unsteady flow around the flat blade cascade is one of the classical problems in fluid mechanics. It involves complex phenomena like vortex shedding, wake interaction and excitation source identification, which is of great interest in engineering applications, such as bridges cross-sections design, hydrodynamic loading on ship stabilizers, tall buildings and rotating machinery field. Experimental investigations and extensive numerical have been done about the free flow around the flat blade cascade by many domestic and foreign scholars. Several experimental studies have been completed successfully. Bull[1] and Blazewicz have conducted a series of flow and acoustic expariments for interacting tandem plates at low to moderate Reynolds number. The velocity and Reynolds stress distributions around the plate were measured and discussed systematically at $\mathrm{Re}=2.3\times10^4\sim3.3\times10^4$ by Kiya and Matsumura[2], Leder[3], Mazharglu and Hacisevki[4]. Lots of numerical studies of the flow around the flat plate have been performed. Dennis carried out the flow around a plate at $\mathrm{Re}=0.1\sim100$, in which the flow was assumed to be 2-D, viscous and incompressible. Then with the improvement of computer hardware, the first 3-D numerical simulation was carried out by Najjar and Vanka[5-7]. Wake patterns, vortex structures, time-averaged pressure and Reynolds-stress distributions were published in the papers. But how to control the vortex shedding and reduce the vibration caused by the shedding effect is a great chanllenge in fluid field. This study focuses on the fundamental flow in a flat plate cascade. The problems like boundary layer flow, wake, vortex shedding and wake interaction will be discussed.

1. Methods

1.1 Numerical methods

Large-eddy simulation is used in the present study, in which large-scale motions are explicitly computed and small-scale eddies are modeled with a subgrid scale model. To ensure numerical simulations, the grid independence test and the verification of numerical models are necessary. The force characteristics of flat blades like drag coefficient and lift coefficient are be monitored. The Strouhal number based on the geometrical characteristics of the flat blade and the frequency of the flow will be calculated as a decidable standard. The calculated model is seen in figure.1.

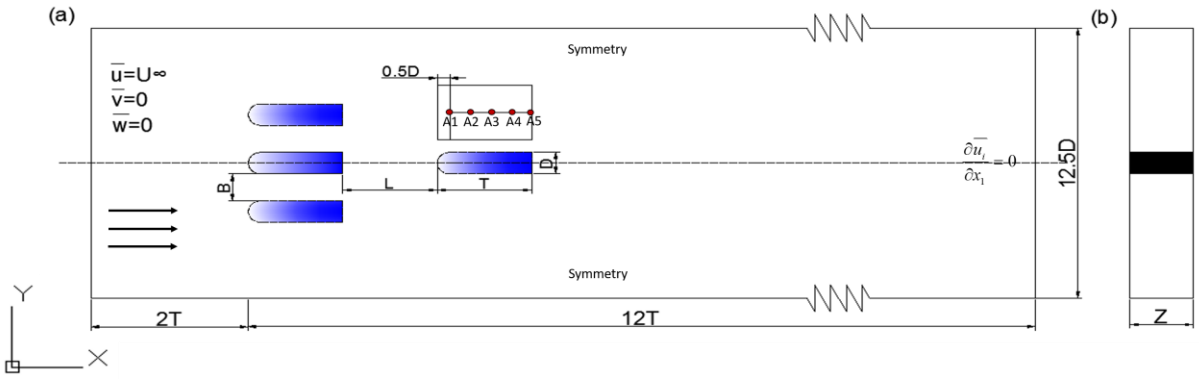

Figure 1

1.2 Experimental measurements

Experimental measurements are performed to validate and supplement the numerical results. The experiments of uniform incoming flow around the flat blade cascade will be carried out using a closed-circuit water tunnel with a working rectangle cross-section of 0.42m 0.1m and a spanwise length of 0.02m. PIV(Particle Image Velocimetry) and LDA(Laser Doppler Anemometry) will be used to measure the structure of the flow around the flat blade cascade under high accuracy and high spatial resolution. Also static pressure pulsation and structure vibration acceleration would be measured by LMS.

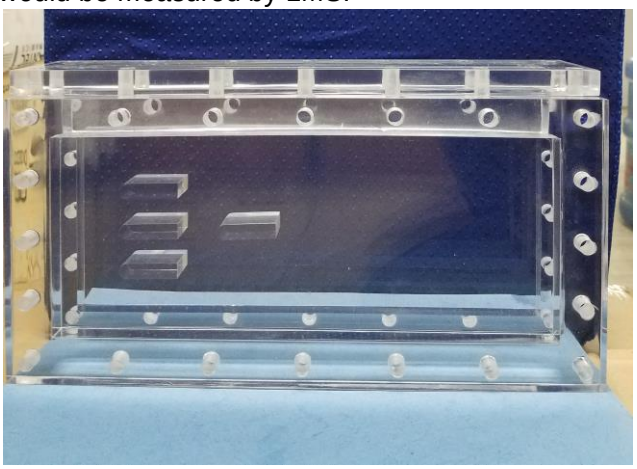

Figure 2

2. Conclusions

（1）The structure of the flow around flat blade cascade exhibits a high degree of three-dimensional characteristics. The flow around the upstream cascade is affected by the downstream plate. The downstream wake presents a typical Carmen vortex pattern.

（2）The existence of a low-frequency unsteadiness in the flow around the flat plate cascade.

（3）The main excitation frequency of the surface pressure on the flat blade cascade is the wake shedding frequency. The downstream plate in the wake, whose surface pressure exhibits a broadband characteristic.

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