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Numerical simulation of unsteady low-Reynolds number flow around rectangular cylinders at incidence

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Abstract

Calculations of unsteady two-dimensional-flow around rectangular cylinders at incidence are presented. The Reynolds numbers are low ($\leqslant 200$), so that the flow presumably is laminar. The results are in reasonable agreement with the indeed scarce experimental data available at these low Reynolds numbers. An incompressible SIMPLEC code is used employing non-staggered grid arrangement. A third-order QUICK scheme is used for the convective terms. The time discretization is implicit and a second-order Crank–Nicolson scheme is employed. The influence of the cylinder side ratio ($B/A = 1$–4) at various angles of incidence ($\alpha = 0°$–$90°$) is investigated. A number of quantities such as Strouhal number, drag, lift, and moment coefficients are calculated. Time sequences of fully saturated flow are also provided.

1. Introduction

For many decades, the flow around slender cylindrical bluff bodies has been the subject of intense research, mostly by experiments but recently also by using numerical simulation. This type of flow is of relevance for many practical applications, e.g. vortex flowmeters, bridges, towers, masts and wires. From an engineering point of view, the prediction of wall pressures, forces, moments and dominating wake frequencies is of great importance. In addition, the study of unsteady slender bluff-body wakes can be motivated from a purely fundamental basis. In many cases, engineering structures have a rectangular or near-rectangular cross section, e.g. beams, fences and other building construction details. Owing to the considerable effort involved in taking unsteady measurements and calculations, our knowledge of unsteady flow around cylinders having non-circular cross sections is limited, especially for rectangular cylinders at incidence.

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