

LBM Calculation for a 3D Cylinder in a Cross Flow

Y. Liu and R. M. C. So
Department of Mechanical Engineering
The Hong Kong Polytechnic University
Hung Hom, Kowloon, Hong Kong
mmyliu@polyu.edu.hk

Abstract

Numerical simulations are carried out for a long slender rigid circular cylinder in a cross flow to examine three-dimensional wake effect on the flow-induced forces. The aim is to assess the validity and extent of the two-dimensional assumption for both the mean drag and the flow-induced forces. In order to simulate the practical situation correctly, wall boundary conditions are specified at both ends of the cylinder. The long slender cylinder has different aspect ratios. A lattice Boltzmann method (LBM) is used to carry out the computations and their results are compared with available experimental and simulation data. As a first attempt to assess the validity and extent of the two-dimensional assumption a Reynolds number $Re = 100$ and an aspect ratio $a = 16$ are chosen. At this Re and a , conventional experimental and numerical studies assume that the time-averaged flow is homogeneous and two-dimensional over a relatively large portion of the central span. However, present simulations indicate that vortex shedding from the nominally two-dimensional cylinder strongly depends on the span location and the flow-induced forces exhibit strong three-dimensionality. The calculated mean drag and root mean square lift and drag vary greatly along the span. These results indicate that the two-dimensional assumption is not valid for the flow-induced forces, not even within a small region of the central span, for the aspect ratio examined. Furthermore, the results show that a has a significant effect on the calculated wake flow and the flow-induced forces.