Wake topology of a surface-mounted block of very small aspect ratio

Barbara L. da Silva
Department of Mechanical and Materials Engineering, Queen's University, Kingston, Ontario, CANADA

The mean wake of surface-mounted finite-height square prisms of very small aspect ratio (herein referred to as blocks) has been well documented based on experimental data. Instead of the quadrupole or dipole wake topology commonly found for taller prisms, the wake of the block features a pair of inner streamwise vorticity regions of the same sign as the base vortices in quadrupole wakes. Similarly to base vortices, the inner vorticity regions have been associated with upwash in the wake, yet their origin has not been explained in detail. This study aims to investigate the inner vorticity regions and their connection to the other features of the flow around a surface-mounted block. Large-eddy simulations were carried out for a block of aspect ratio AR = 0.5, at a Reynolds number of $Re = 1 \times 10^4$ (based on the width D of the block). A thin and laminar boundary layer (LBL) and a thick and turbulent boundary layer (TBL) have been considered. The wake for the LBL case had stronger downwash and a wider horseshoe vortex, but the overall topology was similar for both boundary layers. The inner vorticity regions were identified for both cases, as illustrated in Figure 1. The three-dimensional flow field suggests that they are connected to the streamwise vorticity characteristic of the top separated shear layer, which suppressed vortex shedding. Future work will provide a comprehensive analysis of boundary layer effects on the mean flow field and address the flow dynamics in the wake of the block.

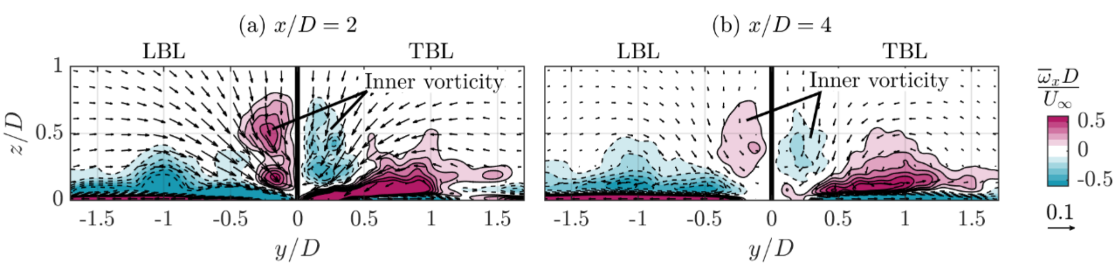

Figure 1. Mean streamwise vorticity and in-plane velocity in a *y-z* plane at (a) *x/D* = 2 and (b) *x/D* = 4. The LBL and TBL conditions are shown on the –*y* (left) and +*y* (right) side of each figure, respectively.

Email address for correspondence: *barbara.dasilva@queensu.ca*