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THEORY AND COMPUTATION OF HIGH REYNOLDS NUMBER FLOW NEAR GROUND CORNER OF A TALL BUILDING

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Abstract

The comfort and safety of pedestrians within the flow environment near the ground corner of a tall building provides the motivation for this study. The problem is modeled using a high Reynolds number asymptotic approach focusing on the local fluid flow in the corner region. Thin boundary regions are found to exist which provide the vertical and horizontal conditions to match to the main nonlinear system which governs the corner flow. The vertical matching condition is found to be a simple displacement mechanism whereas the horizontal matching condition is itself derived from the solution of a nonlinear system. Solutions are obtained analytically and numerically. It is found that nonlinearity affects the solution for relatively small values of the building width, and gives rise to computational difficulties just downstream of the building. The velocity profiles near this location are investigated and we find that the solution cannot be continued beyond this point unless a hitherto-neglected pressure term in the streamwise momentum equation is reinstated.

Keywords: high-Reynolds Number, boundary layer, nonlinear system, asymptotic approach.

Introduction

We are concerned with the environmental impact of proposed buildings, as well as on a more local scale with the effect of the flow-field on pedestrians walking past the ground corner of a tall building. The motion within the atmospheric boundary layer is generally turbulent with the wind changing speed and direction rapidly. As far as we are aware, the most current theoretical work carried out in this area is by Walton and Smith (1997). This model is based on the steady laminar three-dimensional motion that is produced near and