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Experimental investigations of the indoor natural ventilation for different building configurations and incidences

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ABSTRACT

This paper presents an experimental investigation of the indoor natural ventilation in terms of wind pressures on the surfaces of cubic buildings of a street located within a high density urban area. Wind tunnel tests over 1:100 scale models for four typical building patterns of a highly populated urban area have been carried out. The variables of the experiments were the building configurations and the incident wind direction. The experimental data are presented in terms of wind pressure coefficient measured on the surfaces of the buildings. The study results gave the evidence that buildings configuration and wind direction are very important factors in determining the induced natural ventilation within urban domains since they characteristically influence the flow yielding differences in wind pressures.

1. Introduction

In building industry, indoor natural ventilation is one of the most important parameters to be considered by planners and architects during the design of new urban areas. This importance arises from the fact that natural ventilation is a very effective tool in enhancing air quality inside indoor domains by dissolution of pollutants, especially as it relates to the health and comfort of building occupants. Natural ventilation inside buildings can be affected by many parameters, which include, wind pressure on building faces, presence of internal and external opening, location of openings, opening size,… etc. Also, direction of the incident wind, the building surface orientation, surrounding shielding and the topography and roughness of the terrain in the upwind direction are another parameters which influence the natural ventilation effectiveness of a structure. All of these parameters are worse to be investigated. However, in the present paper, authors are investigating only the effect of pressure distributions and pressure coefficients variations on the natural ventilation inside high density building arrays.

Wind pressure is known to be an essential source of power for natural ventilation. By creating high and low pressures on the different faces of buildings, wind motivates the air flow inside buildings and these flows are strongly dependent on wind pressure gradients. In the same time, the arrangements of adjacent buildings and ambient wind directions are considered the most important parameters which control wind flow characteristics and hence natural ventilation performance of local wind inside urban domains [1]. So, it is worth to investigate these factors for a better understanding of the processes which determine the effectiveness of local wind inside urban domains in inducing natural ventilation.

Wind pressures on buildings were studied by many researchers. However, no literatures were found about wind pressure distributions on groups of cubic buildings located within high density building arrays. Tsutsumi et al. [2] carried out wind tunnel experiments to study wind pressure characteristics on one building among a groups of adjacent buildings under different conditions. They discussed the relations between the average pressure coefficients on the building surface and various layouts of buildings. Wiren [3] presented a wind tunnel investigation of pressure distributions on a single building surrounded by identical buildings in various arrays. He concluded that the density of the surrounding buildings affects the distribution and the magnitude of pressure on the test building surface. Also, Stathopoulos et al. [4] studied experimentally the effect of a single span, double span and multi-span roofs of low buildings on the value of wind pressure coefficients. They concluded that the addition of spans to a single span gable roof model generally increases values of wind pressure coefficient measured on the roof, and the effect of additional spans is most evident in the trough and corner areas and for steeper roofs. Jiang et al. [5] investigated the mechanism of natural ventilation driven by wind force using

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