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Effects of architectural shapes on surface wind pressure distribution: Case studies of oval-shaped tall buildings

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Abstract: Natural ventilation has been an important strategy for the improvement of indoor air quality and human thermal comfort, and the reduction of energy consumption of buildings. Many investigations have been conducted to examine the natural ventilation of low, multi-rise buildings rather than tall buildings. Starting from enlarging the wind pressure difference to create wind-driven natural ventilation, this paper aims to analyze characteristics of surface pressure coefficients over tall buildings and to identify the influence of building shapes on coefficient distribution. Taking oval-shaped high-rise buildings as examples, this paper numerically investigated the effects of height-width ratio (HWR) and height-thickness ratio (HTR) on mean wind pressure coefficients (C_m) of building surfaces. Results indicated that windward side of oval-shaped buildings suffered from positive wind pressure, while side, top and back surfaces were basically in negative pressure areas. The absolute values of C_m on building surfaces increased as the decrease of HWR. On the contrary, C_m near central axis of side surfaces showed opponent trend due to fluid separation. In HTR scenario, C_m on windward and top surfaces were greatly affected, increasing along the HTR values. However, with the decrease of HTR, properties of wind field on leeward surface changed. Through this work, the architects and HVAC engineers can get a master plan of in which place they can set possible openings for the creation of possible ventilation paths.

Keywords: Natural ventilation; Wind pressure coefficient; height-width ratio; height-thickness ratio; oval-shaped building

1. Introduction

Natural ventilation has been acknowledged as one of the most effective approaches to improve the indoor air quality and enhance the human thermal comfort, and then consequently to reduce the energy use of regulating indoor environment by the adoption of heating, ventilation and air conditioning (HVAC) system (Cheung and Liu, 2011; Yang et al., 2014). Therefore, it has received great attention in designing and constructing green buildings (Haase and Amato, 2009; Paul and Taylor, 2009; Bauer