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Study on Facade Openings Design Method Responding to Urban Ventilation Issue in High Density Cities

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Abstract

Urban ventilation environment is closely related to temperatures in urban area and Urban Heat Islands (UHI). The relationship between urban spatial forms and urban ventilation should be analyzed from different scales. In this study, four typical cases in Shanghai (SH) and Singapore (SG) were selected as samples to conduct the research. As for research methods, software simulation and measurement were both carried out. The discussion of the results of measurement were as follows: the influence of different ventilation corridor forms on wind speed, the influence of different facade openings forms on wind speed, and influence of wind speed on temperature. Finally based on the above analysis and discussion, the specific suggestions about facade openings design methods were proposed, including: the orientations and locations of the openings, the sizes of the openings and the shapes of the openings.

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Keywords: high-density cities; wind environment; surface roughness; windward side density; facade opening; wind corridor

1. Background

Wind is a movement of air caused by the different atmospheric pressure, and the urban wind environment is an important part of urban physical environment. The term urban wind environment in this paper refers to urban regional atmospheric circulation caused by non-uniformity of the air in weak or calm wind condition. [1]

The continual developing of cities with high-density urban patterns results in sharp increasing of building size in urban centers, growing densities and heights of buildings, coupled with the heat released by a large-scale gathering humans, all these reasons have led to the deterioration of urban wind environment. [2] Spatial morphology of high-density urban influences its special constitutes and wind environment, and there has formed a different wind

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environment in urban area compared with the natural wind. The impacts of construction in high-density urban areas to urban wind environment mainly locate in the following aspects:

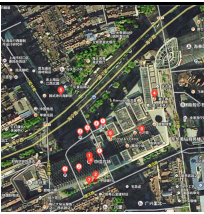
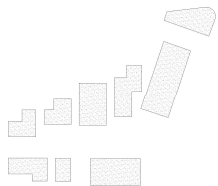
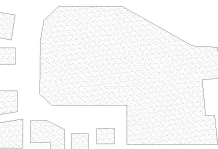
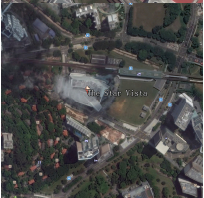
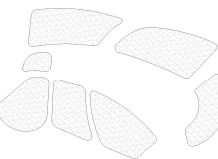
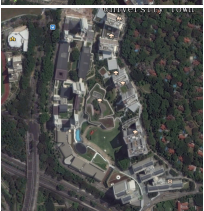
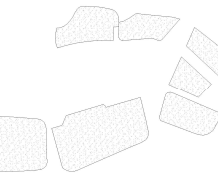
- In the urban level, the concentration of high-rise, large scale buildings results in more rough underlying surface in cities and decrease the urban wind speed;
- In the block level, the improper location of high-rise, large scale buildings and poor layout effect the utilization of city's ventilation corridors especially in weak wind or calm wind ventilation situation, and reduce the efficiency of air flowing in the city;
- In building level, closed building facade make it easily to form a wind shade zone in the leeward side of the building. Over-reliance on ventilation equipment while ignoring consideration of natural ventilation result in a lack of natural wind inside the building and sluggish clean air. [3] [4]

Improving urban wind environment can help to reduce intensity of urban heat island and promote air circulation, thereby to increase the overall comfort level of the urban. The design of form of architecture should base on the sustainable, green, and energy-saving and other core principles of today's architectural design with multi-level, multi-angle considerations from the urban level, block level to building level, and which should also respond to the increasingly prominent urban environmental issues, which is the starting point and significance of this paper.

2. Methods

2.1. Cases selection

Table 1. Cases introduction

Names of Cases	Surround context	Diagram of Typical Plans	Wind corridor characteristics
1.CITIC PLAZA (Shanghai)			Linear wind corridor.
2.WESTGATE Mall (Singapore)			L-shaped wind corridor
3.BUONA VISTA Mall (Singapore)			The curved wind corridor
4.ERC of NUS (Singapore)			The multiple corridors

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