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Numerical simulation of outdoor wind environment of typical traditional village in the northeastern Sichuan Basin

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Abstract

Since the Guideline of Strengthen Preservation and Development of Traditional Village enacted, the traditional villages gradually gain academic concern and many achievements are acquired. But the study about outdoor wind environment is still insufficient. In this paper, the outdoor wind environment of Liyuanba Village in Bazhong City of Sichuan Province – a typical traditional village in the northeastern Sichuan Basin, is simulated by CFD methods. According to the simulation result, the outdoor wind environment in winter is comfortable for people in general, but there are still eddies and corner flows in some areas. To improve the outdoor wind environment, the suggestions such as changing the direction of courtyard and building are put forward. Furthermore, the optimization is also simulated and these two simulation results are compared in the end.

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Keywords: Outdoor wind environment; Typical traditional village; CFD simulation; Optimization of layout

1. Introduction

With the development of tourism since 1980s, the words that Ancient Village and Traditional Village have appeared in people's life. However, with the acceleration of the urbanization after the reform and open-up, increasing the urban population size and economic aggregate requires a large of spatial resource, which leads to a lot of traditional villages near the city suffer destruction and self-destruction [1]. Under such circumstance, some

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traditional villages disappear and some turn to modern village or small town, and the distribution of the traditional village presents a marginal characteristic now [2]. Traditional villages concentrate a great deal of experience of construction by ancients and record the history and culture of this area during long history, their rapid disappearance draws the attention from the government, academia and public. So as to protect and develop the traditional villages, the government enacted a series of guidelines, such as Regulations on Protection of Famous Historical and Cultural Cities and Towns and Villages enacted by the State Council in 2008 and the Guideline of Strengthen Preservation and Development of Traditional Village enacted by MOHURD in 2012. As for academia, many researchers conduct extensive researches for traditional villages and obtain abundant research achievements. The spatial distribution [3], the landscape [4], the evaluation index system [5], the development strategy [6] of the traditional village, the influence by tourism [7], and the difficulty and challenge protected the traditional village faced [8] are the focus of attention. Some technologies such as ArcGIS, Stra-ccm+, PHOENICS are used. But the research about outdoor wind environment of traditional villages is still insufficient.

The specific combination of topography and layout of one village can create a micro-environment, which affect the natural ventilation in this region. Moreover, the natural ventilation forced by wind pressure, heat driven or combination of them, plays an essential role in living environment quality – it can improve the living comfort level, refine the air quality, and even reduce the building consumption. As for the traditional village, their site selection and layout make best use of the natural and climate environment while responding to the natural environment and climate, which improve the living quality for local residents [9]. So in this paper, a traditional village – Liyuanba Village is selected as an example whose outdoor wind environment is investigated by CFD method, and based on the analysis of the simulation result, some improvements in layout are put forward. Furthermore, the advanced layout is also simulated and the result is compared with the in-situ result.

2. Description of the case

Liyuanba Village, which is collected in China's traditional villages catalog in 2014, is a typical traditional village in the northeastern Sichuan Basin – in Bazhong City of Sichuan Province, where is subtropical humid monsoon climate, with annual average temperature 16.9 degrees Celsius, the average January temperature of 5.8 degrees Celsius, the average August temperature of 27.3 degrees Celsius and the average annual rainfall of 1150 mm. The village locates in Daba Mountain, which elevation is between 560m to 698m, while the average elevation is over 500m. The buildings locate in flat strip – ranges from 0 to 25 degrees – of the whole village region. According to the topography, the village region can be regarded as two terrace – Upper terrace in northwest of the region and Lower terrace in east. Throughout the village, there are 58 courtyards adopted through type timber frame with good preservation, including 28 courtyards constructed during Ming and Qing Dynasty, which coagulate the planning experience by ancients in long-term practice. And the layout of the building in this case include courtyard house, a triple house courtyard and detached building. As for building orientation, almost all courtyards face southwest.

Table 1. the month average temperature of Liyuanba Village (1971-2000).

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Average temperature(°C)	5.8	7.8	11.8	17.2	21.6	24.7	26.9	27.1	22.4	17.3	12.2	7.3

3. Methodology

3.1. Methods

To study on the outdoor wind environment of this Typical Traditional Village, a computational fluid dynamics (CFD) method is used. CFD Technique is a kind of numerical simulation technology under the control of the fundamental equations of flow. The spatial distribution of the basic physical quantities (such as speed, pressure, temperature, concentration, etc) in complex problems, and these physical variables changes over time are obtained by applying the CFD Technique [10].

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