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Numerical Simulation and Optimization Strategies of the Wind Environment in the Old Urban Area of Hefei City, China

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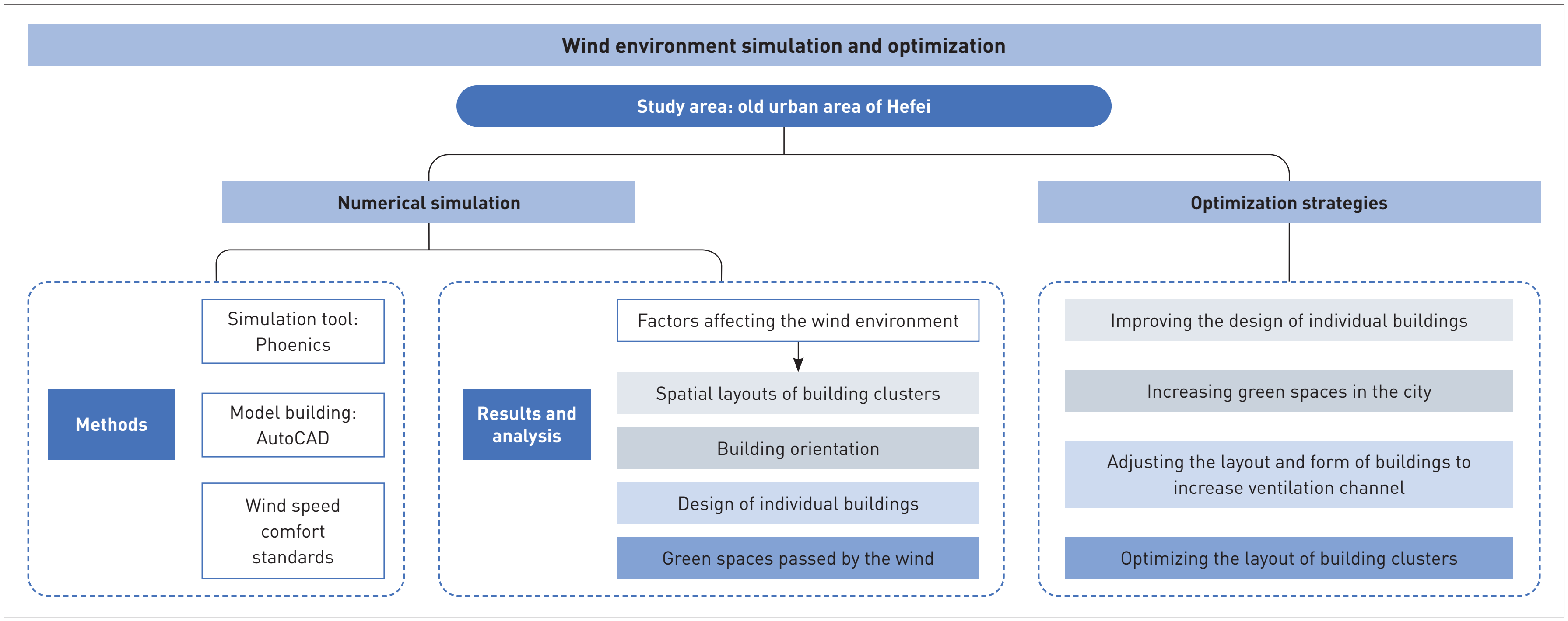
GRAPHICAL ABSTRACT



ABSTRACT

With the acceleration of urbanization, urban wind environment problems are becoming increasingly prominent, directly affecting air quality and residents' quality of life. The complex layout of old urban areas restricts wind circulation and is prone to forming unfavorable wind environment zones. This study takes the old urban area within Hefei City Ring Park as the study area by selecting three representative blocks, establishes three-dimensional models, and employs Computational Fluid Dynamics (CFD) numerical simulation to analyze wind velocity distribution in the study area and the key influencing factors. Simulation results show that, influenced by a combination of multiple factors, the wind environment of the old urban area varies significantly. This study then proposes corresponding optimization strategies for the wind environment conditions of each block, such as adjusting the layout and form of target buildings, optimizing the layout of building clusters, increasing green spaces in the city, and improving the design of individual buildings. Comparing existing and optimized simulations validates the effectiveness of these strategies. Finally, the research compares the existing and optimized wind environment conditions, providing empirical support and scientific guidance for optimizing wind environments of old urban areas and promoting high-quality urban renewal practices.

KEYWORDS

City Ring Park; Old Urban Area; Wind Environment; Computational Fluid Dynamics; Numerical Simulation; Optimization Strategy

HIGHLIGHTS

- Analyzes the wind environment of Hefei's old urban area, exploring influencing factors like buildings and green spaces
- Proposes wind environment optimization strategies and verifies the effectiveness via simulation
- Explores how wind environment is impacted by buildings and green spaces, offering a new method for urban renewals

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1 Introduction

With the acceleration of global urbanization, the continuous expansion of city scale, and the boost in population density, inefficient urban ventilation, calm airflow, and inadequate pollutant dispersion have significantly influenced residents' quality of life, urban ecological resilience, and sustainable development[1]. Old urban areas, due to the historical legacy of complex building layouts, narrow roadways, scarce green space, and other issues, often suffer from the obstruction of wind circulation, which is prone to forming adverse wind environment zones with low wind speed. This in turn exacerbates the urban heat island effect and air pollution, and poses a serious threat to the health of residents[2].

2 Literature Review and Research Design

Research on urban wind environments began abroad in the 20th century, initially focusing on wind tunnel experiments, field measurements, wind loads on high-rise buildings, and the impact of wind fields on pedestrians[3]. Studies revealed the relationship between building forms and wind environments through model experiments[4][5]. Computational fluid dynamics (CFD) is a numerical simulation technology that employs mathematical models to computationally analyze gas flow patterns within built environments[6]. Compared with traditional on-site measurements and wind tunnel tests, CFD offers distinct advantages including short simulation cycles, low cost, and intuitive visualization of results, which have enabled its widespread application in quantitative analysis of spatial elements' impacts on wind environments[7]. Zhengtao Ai and Cheuk Ming Mak[8] used CFD to investigate wind-induced single-sided natural ventilation in buildings near long street canyons under perpendicular winds, exploring building envelope design for improving urban natural ventilation. Another study has assessed the impact of urban morphology and the number of CFD-simulated wind directions on pedestrian wind comfort and safety for five cities with different terrains, and put forward safety-oriented suggestions on wind directions[9].

In terms of technical methods, the employment of CFD software, typified by Phoenics and Fluent, has significantly advanced the comprehension of the influencing factors of spatial elements on the wind environment. For example, research has shown that the green space system enhances urban ventilation corridors through Phoenics simulations[10], and verifies the regulatory patterns of building morphology on the ventilation efficiency of the old inner city of Wuhan with Fluent[11]. In terms of research subjects, existing studies have mostly focused on newly built urban areas or individual building types, while research on old urban areas with complex historical textures is relatively scarce[12]~[14]. In recent years, scholars have begun to explore the impact of multi-factor interactions on the wind environment. For instance, a study on the co-evolution of high-rise architecture and urban vegetation revealed that vegetation-aligned streetscapes reduce air temperature, whereas intersections with primary ventilation corridors may slightly elevate temperatures[15]. Additionally, CFD-based comparative analyses of spatial layout schemes have been employed to optimize urban form, improving air quality through evidence-based design interventions[16].

As the differentiated characteristics of research subjects are increasingly valued, scholars are conducting specialized explorations of cities in different regions. Recent research efforts have leveraged CFD to propose strategies for old inner city renewal by optimizing ventilation efficiency in Changsha, a subtropical monsoon climate city with distinct seasonal wind patterns[17], and quantified the wind environmental adaptability of courtyard layouts in mountainous regions, focusing on microclimatic performance and human comfort[18]. Research on the wind environment of enclosed residential areas has employed CFD to analyze characteristic airflow patterns in cold regions and proposed targeted optimization strategies to enhance thermal comfort and air quality[19]. Scholars have employed field measurements and CFD simulation methods to study the wind environment of residential areas in Hangzhou, a city located in the subtropical monsoon climate zone with distinct seasonal wind patterns, and proposed landscape optimization strategies[20].

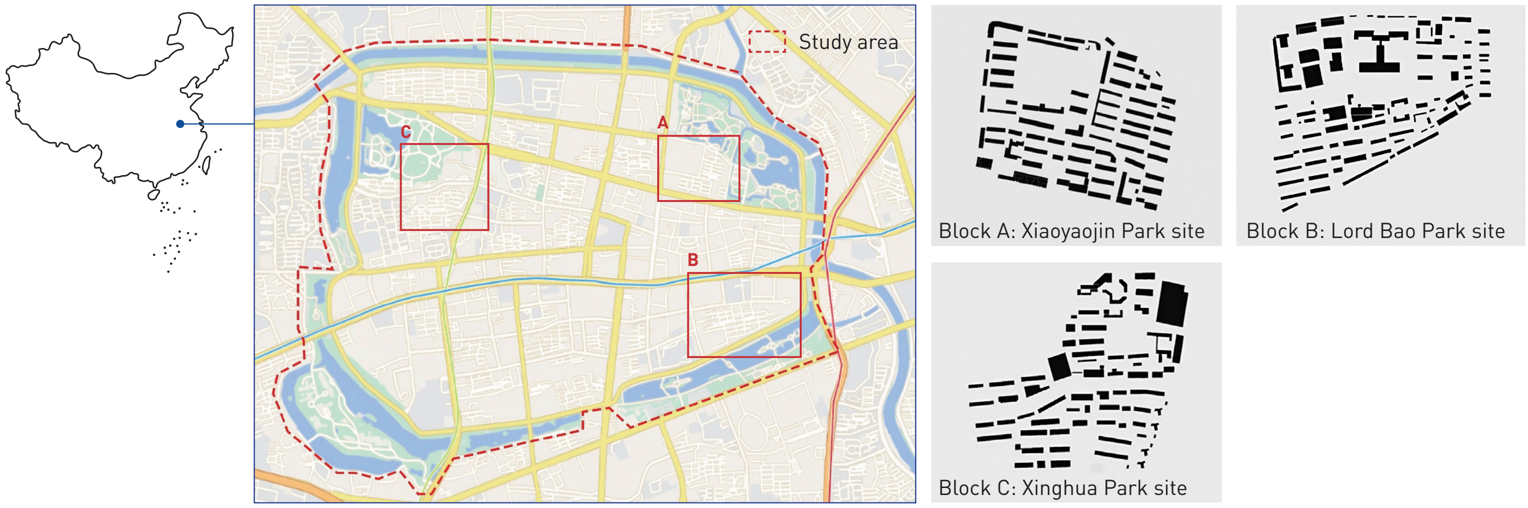
Currently, however, there is insufficient research on the synergistic effects of building–green space composite systems, especially lacking spatial intervention research on the wind environment of old urban areas by such linear ecological infrastructure as urban Ring Parks. Therefore, this research demonstrates an in-depth study of the wind environment of the old urban area within the Hefei City Ring Park and proposes scientific and reasonable optimization strategies for improving the urban microclimate and residents' living comfort.

As an urbanized city in the Yangtze River Delta of China, Hefei is facing the dual challenges of old urban area renewal and ecological protection. As an important part of Hefei's green space, City Ring Park plays a great role in ecological regulation and recreation, and the wind environment of its old urban area directly affects the quality of life of the surrounding residents. Using Phoenics to simulate the wind environment of three representative blocks along the City Ring Park, this study attempts to reveal the ventilation regulation patterns of the ecological infrastructure such as the City Ring Park in old urban areas. By integrating architectural spaces with urban green spaces, the study explores the effects of various spatial elements on the wind environment of old urban areas. Finally, targeted optimization suggestions for the architectural layout and green space planning are proposed to improve its wind environment, exploring innovative paths for the coordinated development of wind environment planning and urban renewals.

3 Study Area

As a typical city with a humid subtropical monsoon climate, Hefei has noticeable seasonal changes in wind direction: in winter, the northeast wind predominates, while the east and southeast winds dominate in summer; and spring and autumn are the seasons of wind direction transition[21]. This study selected the City Ring Park and the old urban area within, located in the city center, as the study area (Fig. 1). The surrounding 1.376 km^2 City Ring Park[22] is a key component of Hefei's green infrastructure system and is characterized by its interwoven river corridors and lush vegetation landscapes. The study area largely retains the historical street and building patterns and is functionally dominated by commercial and residential spaces, where most of the building layouts are characterized by courtyard-style clusters. The area has a high floor area ratio, dense buildings[23], and poor ventilation conditions, resulting in a serious urban heat island effect[24].

This study selects three representative blocks adjacent to



Block A: Xiaoyaojin Park site

Block B: Lord Bao Park site

Block C: Xinghua Park site

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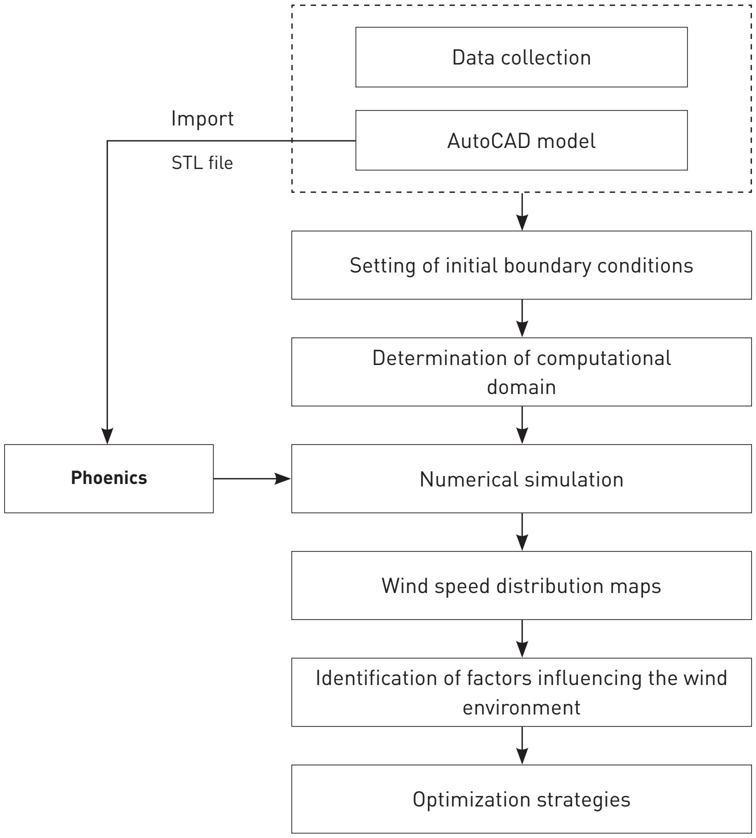
1. The site map of Hefei City Ring Park (created based on the standard map from the Department of Natural Resources of Anhui Province, map number GS [2024] 0650), and layouts of the three blocks within the study area (sourced from Mapbox).

Xiaoyaojin, Lord Bao, and Xinghua Parks, respectively (Fig. 1), which are important components of the City Ring Park. These blocks, with varied green space types and building layouts, can collectively reflect the typical microclimates of Hefei's old urban areas: the Xiaoyaojin Park site (Block A) features linear-row residential compounds aligned with spring-summer southeasterly winds, representing common old-city layouts that may guide or obstruct airflow; the Lord Bao Park site (Block B) combines linear architectural rows and enclosed courtyards with buildings almost orthogonal to dominant warm-season winds, making it ideal for analyzing calm wind zones within mixed layouts; and the Xinghua Park site (Block C), exposed to northwestern winds funneled by the eastern topography, providing a contrasting case for seasonal wind environment analysis.



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4 Research Method

In this study, the CFD software Phoenics is mainly used to carry out numerical simulations and analyses. In addition to the function of calculating fluids, Phoenics also has the advantages of visualization, a CAD interface, a large number of models to choose from, and various modules for different fluid simulation analysis scenarios[25]. First, data collection and AutoCAD modeling are conducted to establish initial boundary conditions. Subsequently, the computational domain and numerical simulations are conducted to generate velocity distribution maps. These results are then analyzed to identify the factors influencing the wind environment, and ultimately optimization strategies are proposed to improve the wind environment (Fig. 2). This research roadmap ensures a comprehensive examination of the wind environment in dense urban areas, informing and facilitating design improvements for related urban renewals.

4.1 Data Collection

The wind speeds within the study area were measured in three kinds of locations—outer boundary of the park (specifically the non-built perimeter immediately adjacent to the park's boundary), within the park (the green space area), and in the built area (the urbanized zone characterized by dense buildings)—to highlight the role of green spaces in ventilation regulation. Five measurement points were selected for each block: starting from the park's boundary, including one point at the outer boundary of the park, one point within the park, and three points in the built area (spaced at 100-meter intervals) (Fig. 3). The wind speed data during the daytime in March and April without special weather events were collected in the three blocks through field measurements using anemometers. The measurement height was set at 1.5 m to simulate pedestrians' apparent wind speed. Through

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2. Research roadmap.
3. Distribution of the measurement points.

calculations, the average wind speed at the points in the built area was determined to be 0.57 m/s, with wind speeds ranging from a minimum of 0.06 m/s to a maximum of 2.40 m/s. Then, referring to the ventilation criteria outlined in the Assessment Standard for Green Building (GB/T 50378-2019)[26], the study identified zones with uneven velocity distribution and inadequate wind conditions in the study area, indicating severe air stagnation in the built area, which exacerbates the urban heat island effect due to reduced natural ventilation. Based on the field investigations, CAD drawings of the study area, building height, and other data provide a database for the subsequent wind environment simulations.

4.2 Setting of Simulation Parameters

The key initial boundary conditions for the CFD simulations include wind speed and direction. According to the recent data from the China Meteorological Data Service Centre, Meteorological Data Set for Building Thermal Environment Analysis in China[27], and the meteorological data from weather monitoring stations in Hefei, the wind speed in the study area ranges from 1.6 m/s to 3.3 m/s. A representative wind speed of 2.4 m/s was determined based on statistically measured values. Site-specific prevailing wind directions were assigned to reflect seasonal airflow patterns: southeast for Block A, southerly for Block B, and northwest for Block C. These directional configurations were implemented independently in simulations to isolate localized wind patterns.

The wind distribution related to height was modeled using the exponential velocity distribution:

$$V = V_0\left(\frac{Z}{Z_0}\right)^{\alpha}, \tag{1}$$

where V denotes the mean wind speed at height Z; V_0 represents the reference wind speed at the standard meteorological height Z_0 (10 m); α is the dimensionless exponent, governing the vertical wind speed gradient, determining the rate at which wind speed changes with height, and varying with ground roughness and atmospheric stability conditions—here a value of 0.2 is adopted in accordance with established standards for built areas[28].

4.3 Model Construction

Based on the analysis results, the wind speed data and AutoCAD files of the three blocks were exported in STL format and imported into Phoenics for CFD simulations. The computational domain of the models was determined, and mesh division was performed on it.

Among existing research, the determination of computational domain in modeling varies case by case, which in this study was determined as follows: the length is three times the maximum length of the block site; the width is three times the maximum width of the block site; and the height is three times the height of the tallest building. To ensure calculation accuracy, this research conducted mesh refinement on the simulation sites to avoid any blank areas.

4.4 Determination of Evaluation Indicators

According to established criteria[29], the velocity physiologically comfortable for humans ranges from 1.3 m/s to 5.0 m/s. Velocity exceeding 5.0 m/s may cause physical discomfort, while velocity below 1.0 m/s can lead to reduced ventilation efficiency and an increased risk of pollutant accumulation. To balance human comfort and microclimatic health, the study adopted the range of 1.3 ~ 5.0 m/s for evaluating the wind environment in the study area (Table 1).

5 Numerical Simulation and Analyses

5.1 Simulation Results and Data Analyses

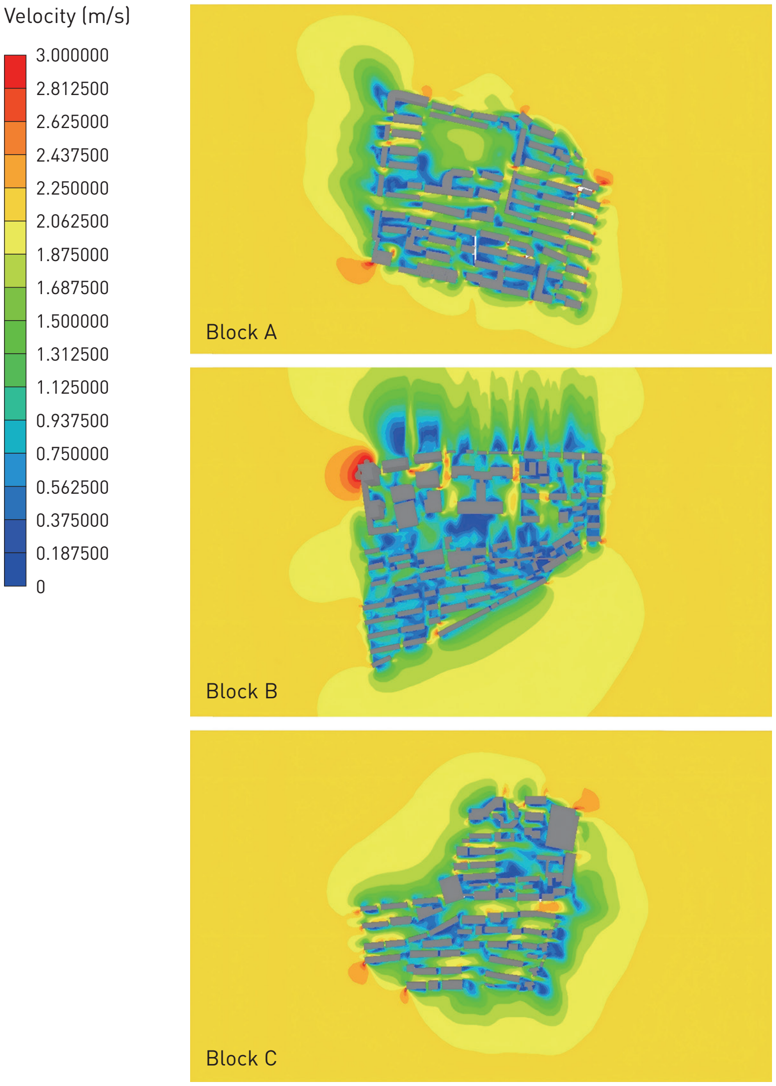
The simulated velocity distribution within the three selected blocks is shown in Fig. 4.

The simulation results show that the existing average wind speed in Block C is 2.07 m/s, while those in Block A and Block B are 2.04 m/s and 1.75 m/s, respectively. Overall, the average wind speed in Block C surpasses that in the other two blocks, and the wind environment is relatively better.

Figure 4 reveals that the architectural layout of Block A significantly influences the wind environment. Most buildings are

Table 1: Wind speed comfort standards

Comfort standard	Wind speed standard (m/s)
Clam wind, extremely low comfort	Velocity < 0.3
Poor comfort	0.3 ≤ velocity < 0.6
Low comfort	0.6 ≤ velocity < 1.0
Generally satisfactory	1.0 ≤ velocity < 1.3
Comfort	1.3 ≤ velocity < 5.0
Affect normal activities and no dust generation	5.0 ≤ velocity < 5.2
Affect normal activities and generate dust	5.2 ≤ velocity < 7.0



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4. Existing velocity distributions of the three blocks.

aligned with the prevailing southeast wind direction in spring and summer. This alignment creates ventilation corridors, enhancing local ventilation performance and improving microclimatic conditions. Conversely, a few buildings oriented perpendicular to the wind direction obstruct airflow, forming areas of slowed airflow. Particularly, in the southeastern part, the orthogonal building orientation and enclosed layouts hinder air penetration, resulting in wind speeds below 0.3 m/s as calm wind zones, increasing the risk of pollutant accumulation and degrading local air quality and human comfort.

Block B exhibits a relatively larger proportion of calm wind zones, suggesting an overall poorer wind environment compared with the other two blocks. Buildings in the southern part hinder the northward penetration of winds into the block. The windward facades maintain speeds exceeding 1.0 m/s, which achieve generally satisfactory level, while the leeward areas exhibit significantly reduced wind speeds below 1.0 m/s featuring multiple calm wind zones. The northern part has better ventilation, mainly due to strategically placed openings between buildings that channel wind ingress. However, the central area, characterized by I-shaped and L-shaped building configurations, exhibits obvious calm wind zones. The obstructed airflow patterns caused by these combined structural forms result in significantly lower wind speeds compared with those observed in the leeward zones of I-shaped buildings.

Block C demonstrates a favorable wind environment. The areas with lower wind speeds are primarily clustered in the spaces enclosed by buildings that face divergent orientations.

5.2 Factors Affecting the Wind Environment

Based on numerical simulation (quantitative data) and relevant literature (theoretical frameworks), several factors affecting the wind environment are extracted. These factors collectively shape the wind flow patterns and microclimatic conditions in the study area.

5.2.1 Spatial Layouts of Building Clusters

Enclosed and rectilinear building cluster layouts determine wind distribution variability across different urban blocks. In the northwestern part of Block A, enclosed building clusters with compact spatial arrangements intensify wind shielding, as their tightly packed forms create significant obstacles to airflow. Behind the windward side of Block B, the lower building density results in superior ventilation performance. A large opening at the southeast corner of the site facilitates air inflow. For Block C, the buildings mostly adopt a rectilinear building layout, the wind-guiding effect of structures in the southern part, which exhibits a certain wind-guiding effect and improves the local wind environment of the eastern part of the block.

5.2.2 Building Orientation

The direction of buildings significantly impacts a block's internal wind environment, especially in the windward zones adjacent to green spaces. Existing research indicates that buildings parallel to the wind direction exhibit the least wind obstruction and the best ventilation performance[30]. Consistently, at Block B, prevailing winds passing through northwest-side buildings aligned with the wind direction reach the maximum speed within the site. Whereas when it flows through buildings at an angle to the wind direction, the wind speed is generally lower than the inflow speed of 2.40 m/s. The windward side of Block B adopting a rectilinear building layout with east-west oriented structures exhibits a significant wind-blocking effect.

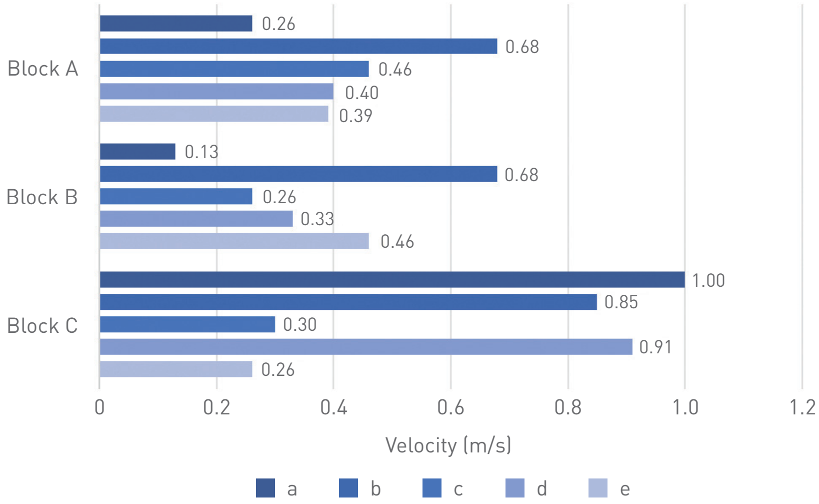
5.2.3 Design of Individual Buildings

Individual building layouts including point-type, L-shaped, and I-shaped types, significantly influence the wind distribution of each block. The simulated velocity distribution maps (Fig. 4) show that various building designs in the block generate different calm wind zones. For example, the simulation results of Block A show that the wind speed in the leeward area of L-shaped buildings is significantly lower than that in the leeward area of I-shaped buildings. For point-type buildings, the wind shadow area is the smallest, resulting in minimal wind obstruction, as seen in the northeast area of Block B.

5.2.4 Green Spaces Passed by the Wind

Green spaces significantly impact the urban wind environment. When the wind passes through green spaces such as urban parks, vegetation facilitates evapotranspiration, lowering wind temperature and increasing humidity, thereby enhancing air quality. The width of green spaces directly enhances their microclimate regulation ability, with increased size intensifying regulatory effects and broadening the affecting range spatially[31].

On a typical southeasterly wind day in Hefei, field measurements of wind speeds at the five measurement points were carried out. The data show that when the wind passes through Xiaoyaojin Park and Lord Bao Park, the wind speed increases significantly. It then flows through the old urban area, and the wind speeds begin to decrease. Meanwhile, in Block C, when the southeast wind first blows through the old urban area, where the wind speed starts to decrease, but after passing through the old urban area and reaching the green space, the wind speed rises again (Fig. 5). This indicates that the green spaces around the city not only foster favorable wind environments but also enhance ventilation in adjacent areas.



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5. Wind speeds at the measurement points.

6 Optimization Strategies

6.1 Optimization Measures

6.1.1 Adjusting the Layout and Form of Target Buildings

To enhance the ventilation efficiency of the old urban area, the boundary permeability of building clusters surrounding the park can be promoted. First, by creating openings in the building interfaces near the inlets of ventilation corridors from the park, the cross-sectional area of these channels can be expanded to add openings appropriately, thereby boosting horizontal airflow and increasing wind speeds.

For example, for the dense building area in the south of Block B (the highlighted parts in Fig. 6), the measure of elevating the ground floor can be implemented to establish wind-guiding channels, to address ventilation obstructions caused by high-level enclosure of buildings.

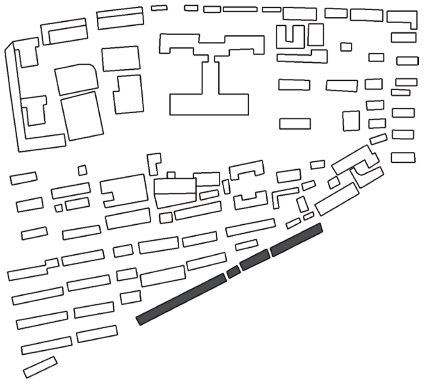
6.1.2 Optimizing the Layout of Building Clusters

Under different wind conditions, the disparity of building clusters leads to significant differences in the distribution of wind speed, wind shadow zones, and turbulent areas, resulting in varied wind environments[32]. Experimental results show that row-style and staggered building layouts enhance airflow in street and alley spaces, significantly improving local ventilation[33]. Therefore, for old urban area renewal, prioritizing scientific layouts of building clusters can create a comfortable outdoor wind environment.

For example, to ensure the air inlets in streets and alleys and facilitate air circulation, Block A (the highlighted parts in Fig. 7) can optimize its building arrangements by adjusting to a row pattern. This will effectively reduce airflow obstruction from wind-perpendicular buildings, thereby enhancing overall ventilation and improving wind comfort.

6.1.3 Increasing Green Spaces in the Built Area

Adding urban open spaces is a key strategy to enhance the ventilation efficiency within old urban areas. Urban open spaces, especially green spaces with ecological regulation effect, can



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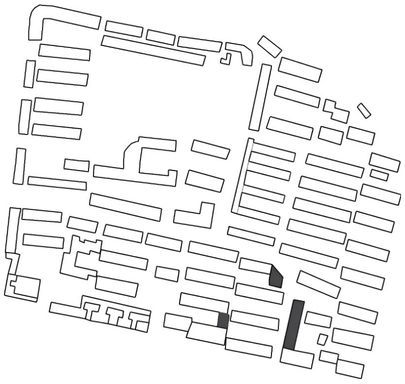

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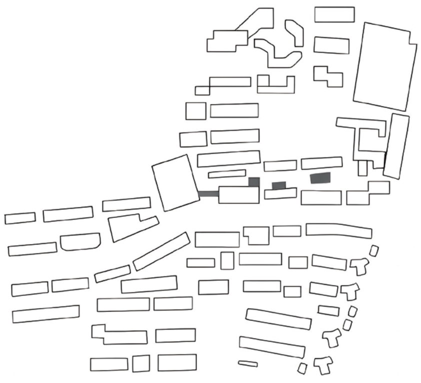

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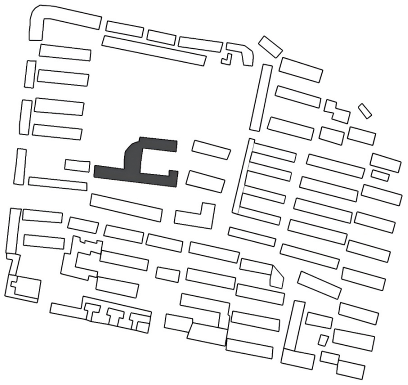

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6. Example of adjusting the layout and form of target buildings.
7. Example of optimizing the layout of building clusters.

8. Example of increasing green spaces in the built area.
9. Example of improving the design of individual buildings.

mitigate wind obstruction by large buildings, particularly in ventilation corridors. Due to the high building density in the old urban area, wind circulation within the blocks is often impeded. By demolishing old buildings and large infrastructure or reasonably adding open spaces, the overall ventilation conditions can be improved.

For example, in Block C (the highlighted parts in Fig. 8), removing older buildings with smaller footprints on the windward side and replacing them with public green spaces can reduce wind obstruction and promote air circulation. Additionally, strategically planning green spaces in open areas or implementing rooftop vegetation can create a cooler microclimate, accelerating air exchange and refreshment.

6.1.4 Improving the Design of Individual Buildings

The form and layout of individual buildings are key factors affecting the wind environment, especially in densely built old urban areas, where unreasonable building design is likely to lead to airflow stagnation. Reducing L-shaped buildings that easily to form turbulence and enlarging the proportion of point buildings can reduce wind shadow areas.

Taking Block A (the highlighted parts in Fig. 9) as an example, one L-shaped and row-type building, due to its layout perpendicular to the southeast summer winds, tends to form a calm wind zone in its leeward area, leading to pollutant accumulation and intensifying the heat island effect. By reducing enclosed individual buildings, wind speeds in the leeward areas can be significantly increased, effectively improving the local microclimate and creating comfortable ventilation conditions for residents' activity spaces.

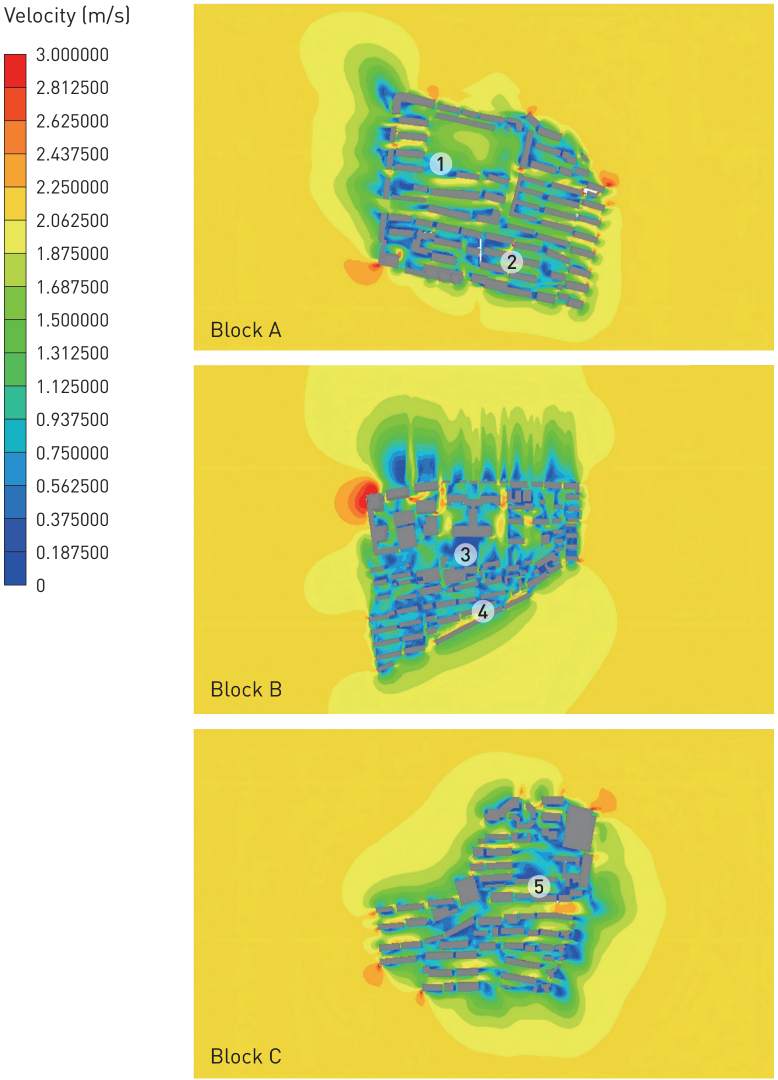
6.2 Simulation Results of Optimization Strategies

Based on the wind environment simulation results after implementing the targeted optimization strategies proposed for each block, to assess the specific before-after effects of optimization strategies, five optimization pilot points (Fig. 10) were selected in the wind environment critical zone(s) of each block, including wind environment critical zones, spatially representative locations, and the locations proximate to optimized buildings. A comparative analysis of wind speed across the three blocks reveals the following findings: after adjusting building arrangements and an individual building design of Block A, the overall average wind speed increases; elevating the ground floor of buildings on the southern side of Block B creates a guiding channel that can reduce calm wind zones; and demolishing old buildings at Block C and transforming them into open spaces minimizes poorly ventilated areas. These findings demonstrate that the optimization strategies can effectively improve the wind environment of the three blocks, providing robust support for old urban area planning and renewal schemes (Table 2, Fig. 10).

6.3 Comparison Analysis of Optimization Pilot Points

After optimizing the building arrangements in the three blocks, a comparative analysis of wind speed at the five optimization pilot points was conducted to reveal the effects of the optimization strategies (Fig. 11).

In Block A, Point 1 is located in the space enclosed by buildings with varying orientations and Point 2 is near buildings perpendicular to the wind direction. After adjusting the layout of buildings that are perpendicular to the prevailing wind direction, wind speeds at both points increase significantly, with the wind



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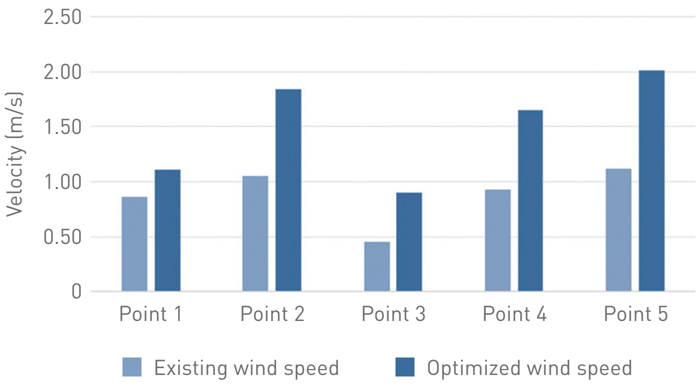
10. Optimized velocity distributions of the three blocks.

Table 2: Existing and optimized average wind speeds

Block	A		B		C	
Condition	**Existing**	**Optimized**	**Existing**	**Optimized**	**Existing**	**Optimized**
Average wind speed (m/s)	2.04	2.08	1.75	1.93	2.07	2.10

environment achieving generally satisfactory and higher ratings, demonstrating enhanced ventilation corridor efficiency.

For Block B, optimization pilot points were in calm wind zones and on the windward and leeward sides of buildings. Through the layout adjustments of the inlets of ventilation corridors, the calm wind zone around Point 3 shrinks, while the wind speed at Point 4 near the inlets of ventilation corridors rises markedly. The redesigned opening sustains airflow enhancement, elevating the comfortable level of wind environment on site.



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11. Wind speeds at the optimization pilot points.

At Block C, Point 5 is within an old building cluster. By removing older buildings with smaller footprints nearby, more open green spaces can be created to improve local ventilation. However, the optimization strategy effectively boosts wind speeds across comfort scales, and the extent of improvement depends on site-specific characteristics and is subject to building density constraints.

7 Conclusions

This study aims to optimize the wind environment in the old urban area within Hefei City Ring Park using CFD technology to analyze wind conditions and influencing factors. The findings reveal that the old urban area suffers from low wind speeds, uneven velocity distribution, and localized poor ventilation. Through simulation analyses, this study clarifies the influencing factors on the wind environment, including spatial layouts of building clusters, building orientation, design of individual buildings, and green spaces passed by the wind. Then it puts forward optimization strategies accordingly and conducts a comparative analysis for the improved effects.

This study proposes a new strategy for old city renewal. It analyzes the wind environment characteristics of old urban areas, uses Phoenics software to simulate the wind environment in architectural spaces, integrates the influence of urban green spaces on the wind environment, and investigates the influencing factors of different spatial elements on the wind environment. Additionally, it proposes optimization strategies and formulates differentiated plans for different blocks based on their specific wind environment conditions. Through simulation and comparison of existing and optimized wind environments, the effectiveness of these strategies is verified, providing new methods for similar high-density old urban areas and serving as a practical model for urban renewals.

The wind environment of the old urban area in Hefei is jointly influenced by multiple factors. This study focuses on four factors of the wind environment. The limitations of this study include incomplete modeling of terrain, unaccounted effects of building surface materials, and a focus on dominant seasonal wind directions without comprehensive directional variation analysis. Additionally, the overall optimization effect of the wind environment in the City Ring Park remains unvalidated. Future research should incorporate more indicators to construct a multidisciplinary wind environment simulation system by integrating geospatial information technology based on climatic zoning, and apply it into the spatial analysis of urban design and urban renewal as direct support for decision-making.

Competing interests | The authors declare that they have no competing interests.

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合肥老城区风环境数值模拟与优化策略

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摘要

随着城市化加速，城市风环境问题日益凸显，直接影响空气质量与居民生活质量。老城区的复杂布局限制了风的流通，易形成不利风环境的区域。本研究以合肥环城公园内老城区为研究对象，选取三个典型场地构建三维模型，运用计算流体动力学数值模拟技术，分析老城区风速分布特征及其关键影响因素。模拟结果显示，老城区风环境受多种因素综合影响，且差异显著。本研究随后针对每个街区风环境条件提出优化策略，包括调整通风廊道入口布局与形式、优化建筑群布局、增加城市开敞空间、改进建筑单体设计、强化环城公园绿地微气候调控等，并通过对比优化前后的模拟结果验证其有效性。研究旨在为老城风环境优化提供科学支撑，推进高质量城市更新实践。

关键词

环城公园；老城区；风环境；计算流体动力学；数值模拟；优化策略

文章亮点

- 分析合肥老城区风环境，探讨建筑物、绿地等影响因素
- 提出风环境优化策略（布局、绿地空间等），并通过模拟验证有效性
- 探讨建筑与绿地对的风环境影响，为城市更新提供新思路

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