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Research Article

Analysis on Indoor Ventilation Environment of House Type Based on Architectural Aesthetics

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Architectural aesthetics mainly creates architectural beauty according to the law of beauty and realizes the interaction between creative subject and object, and receptor. Its essence has been soaked and attached to all kinds of materialized carriers and behavioral subjects in the living environment. Through the aesthetic optimization of residential house type, this paper analyzes the ventilation efficiency of representative house type, which affects the prevention and control of community infectious diseases and the physical and mental health of residents. Take multiple measures to strengthen the aesthetic design of residential house type, and promote the healthy development of community ecology and the cultural inheritance of harmonious society. It is helpful for architectural designers to improve their understanding of the effect of natural ventilation and provide reference means for designers to reasonably organize indoor natural ventilation in architectural design.

1. Overview of Architectural Aesthetics and Aesthetic Characteristics of Architectural Design

The related concepts of aesthetics have always been an important content discussed by ancient and modern scholars. They also define aesthetics from different angles. Aesthetics is essentially the study of beauty. Generally, it focuses on artistic works. After analyzing the forms and characteristics of artistic works, it analyzes the deep-seated aesthetic ideas contained in them. In the process of rapid socioeconomic development, people's living standards are improved, accompanied by the improvement of aesthetic cognition. Aesthetic cognition is an important psychological process of human beings. The aesthetic experience model proposed by Leder et al. in 2004 emphasizes the importance of cognitive judgment for abstract art cognition [1]. Aesthetic cognition is generally influenced by cognitive traits and emotional traits [2]. Psychological experiments show that the neural network of aesthetic cognition and social and moral judgment partially overlaps [3]. Aesthetic form is a specific form of expression. We should analyze things from multiple angles. In architectural design, Sino-American studies are reflected in social beauty, natural beauty, and artistic beauty.

Architectural aesthetics plays an important role in both artistic aesthetics and architecture. It is a new discipline that deeply studies the beauty and aesthetic problems in the field of architecture based on architecture and aesthetics. Architectural aesthetics mainly creates architectural beauty according to the law of beauty and realizes the interaction between creative subject and object, noumenon, and receptor. Generally speaking, architectural aesthetics includes narrow sense and broad sense: the main purpose of narrow sense architectural aesthetics is to show the laws and artistic characteristics of single architectural modeling beauty, while broad sense architectural aesthetics pays more attention to the boundary conditions of architectural aesthetics and grasps the characteristics of beauty from various macro perspectives such as the relationship between buildings and surrounding environment, In architectural aesthetics, it

mainly includes the aesthetic essence and characteristics of architectural art, the relationship between aesthetic creation and life, and the rules of formal beauty of architectural art. One is to highlight the beauty of the building. The rational application of architectural aesthetics in house design can directly enhance the beauty of the building. Among them, the aesthetics of house design is embodied in shaping space shape, reasonably arranging space color, correctly selecting space scale, and arranging and combining space. The second is to highlight the harmony of architecture. Through the rational use of natural landscape to design the aesthetics of housing architecture, we can ensure that it is in harmony with the natural environment. In essence, space composition can better meet the requirements of function for space. Third, highlight the humanism of architecture, adhere to people-oriented humanism, and make full use of modern technology to build a harmonious relationship between man and the natural environment, create an ecological environment, and create a high-quality living environment. Fourth, highlight the regionality of architecture. Affected by the differences in social development level and natural conditions, the application of architectural aesthetics in housing design can organically combine regional characteristics, such as colors, patterns, and graphics, to form architectural styles in different regions.

In the design of modern architecture, the geometry inside and outside the building is basically unified. Measures are taken to coordinate various positions to ensure that the secondary position obeys the primary position, forming a subordinate relationship as a whole. The penetration of geometry is reflected in architectural details, which can reflect the overall coordination from inside to outside. It also pursues unity and coordination in color application. The color comparison of materials is an important way to obtain unity. In many historical designs, red wall and gray form contrast and achieve a high degree of unity at the same time.

In architectural design, balance is also an important principle to be observed. First, determine the center to ensure that the designs on both sides are basically consistent. Symmetry is an important embodiment of balanced design. Many successful architectural designs are designed in a symmetrical way, which is more natural and gives people a sense of beauty.

In architectural design, it is very important to grasp the size, and dynamic proportion design is an important part. Perfect proportion is often helpful to establish a coordinated position size relationship, which is very important to establish a harmonious internal relationship of the building.

From the perspective of aesthetics, the graphic design of architectural layout mainly considers unity and coordination, design balance, reasonable design proportion, and so on. In the design of modern architecture, the geometry inside and outside the building is basically unified. Measures are taken to coordinate each position to ensure that the secondary position obeys the primary position, forming a master-slave relationship as a whole. The penetration of geometry is reflected in architectural details, which can reflect the overall coordination from inside to outside. In architectural design, balance is also an important principle to be observed. First, determine the center to ensure that the designs on both sides are basically consistent. Symmetry is an important embodiment of balanced design. Many successful architectural designs are designed in a symmetrical way, which is more natural and gives people a sense of beauty. In architectural design, it is very important to grasp the size. Dynamic proportion design is an important part, such as the ratio of square edge to diagonal, the interrelated rectangular series developed from a single square (producing the golden section), etc. Perfect proportion often helps to establish a harmonious relationship between location and size, which is very important to establish a harmonious internal relationship of the building [4].

2. Aesthetic Requirements for Indoor Ventilation Environment of Residential House Type

The natural ventilation of buildings is the air flow caused by the air pressure difference at the openings (doors, windows, and corridors). The exchange of indoor and outdoor air flow can reduce the room temperature and eliminate moisture, so as to ensure the normal climate conditions and fresh and clean air of the room. At the same time, there is a certain air flow in the room, which can strengthen the convection and evaporation heat dissipation of the human body, improve the thermal comfort of the human body, and improve people's working and living conditions. The causes of pressure difference are thermal pressure and wind pressure.

Residential house type is an architectural design product related to the vital interests of the people. There are a large number of residential house type design products in Shanghai market, both good and bad, and different evaluation standards. Zhu Feng, from the standpoint of architects, took applicability, economy, and aesthetics as the main considerations, eliminated unnecessary interference factors, and constructed a house type evaluation system. The system first finds out several key evaluation points that have the greatest impact on residential house type design, then defines the score proportion of each evaluation point, then sets the scoring standard for each evaluation point, and finally makes a relatively rational overall score for a house type, so as to judge the quality of house type design. Among them, the evaluation points based on aesthetics mainly include the squareness of the room, the interference degree of streamline, the opposite view, the opposite scene, and the flatness of the facade [5].

In the process of urban residential house type design, the fundamental problem that designers need to pay attention to is how to achieve the matching of residential use function in a limited area and scope. The structural types of house types in urban housing include living room, bedroom, kitchen, toilet, etc. Designers must correctly deal with the relationship of various structural types in spatial layout. In addition to meeting the master-slave relationship, internal and external relationship, and dynamic and static relationship of different structural spaces, they should also make the final designed residential house type as comfortable, safe, and green as possible. In the design of house type layout, we

should also make the layout of each indoor structural space as smooth as possible, compact, and centralized and maximize the effective indoor use area of residential house, so as to increase the practicability of residential house type. In order to further improve the quality level of house type design, we should also introduce the humanistic design concept. In addition to meeting the practical characteristics, the design of residential house type also needs to protect the personal safety and personal privacy of residents in the house as much as possible. When talking about art and knowledge, German art appraiser Max J. Friedlunder said the following: "artistic activities—whatever it may be—are first and foremost an emotional spiritual process, so any scientific art research must belong to the category of psychology. It may also involve other fields, but if it belongs to psychology, it will never change" [6]. People will selectively further process some aspects of the aesthetic object, activate memory, give meaning, and make aesthetic judgment [7]. Especially in the context of the development of urban housing commercialization, most residential house type designs do not fully reflect the characteristics and style of humanization. For example, some commercial houses blindly pursue to create a large living room space, and the area division in each structural partition is unreasonable, which is often difficult for consumers to accept. Only when designers fully consider the coordinated development of house type design scheme and surrounding environment, can they make the residential interior have good ventilation and lighting conditions, and then create a good and comfortable residential space environment. For example, in small family houses, ventilation is often unfavorable due to many partitions and small space. The increased wall opening makes the indoor and outdoor natural ventilation smoother and strengthens the internal ventilation. The indoor air can circulate, forming a good ventilation environment, which is conducive to the cleaning and renewal of indoor air, odor elimination, and dehumidification.

Residential house type design involves many disciplines such as residential sociology, residential psychology, residential physiology, residential behavior, residential ergonomics, and residential environment and develops in the direction of "comfort," "adaptation," "intelligence," "standardization," and "reasonable area." It is necessary to consider the satisfaction of indoor physical environment (air environment and acoustic environment) to the physiological requirements of residents. Psychological research shows that people focus on pleasant vision [8]. Indoor air environment mainly depends on ventilation. Reasonable opening of windows and door openings should be considered in the design of houses. The development trend of residential apartment layout is healthy green and comfortable. Apartment layout design should focus on natural ventilation and effectively improve indoor air quality and sanitation, especially in the community when dealing with infectious diseases. For example, regarding current COVID-19 prevention and control, keeping indoor ventilation well is particularly important. In addition, if designers pay attention to ventilation before residential design, they can also save the use frequency of air conditioning. As the basic form of human survival experience, residential space constitutes the internal life meaning of art and plays an important role in forming the artist's main experience. Different times have their own space forms, thus forming a specific space experience and aesthetic pursuit [9].

As a passive ventilation and cooling method, natural ventilation has attracted more and more attention. It can meet the requirements of people getting close to nature and is more conducive to people's physical and mental health. However, how to reasonably organize natural ventilation and maximize the use of natural resources is a difficulty in architectural design. In order to ensure the thermal comfort of indoor personnel and indoor air quality during the dynamic change of natural ventilation, it is necessary to control natural ventilation. The natural ventilation effect of residential buildings is closely related to the structure, layout, building orientation, and outdoor environmental wind direction of buildings (windows, doors, walls, etc.). At present, there are many studies on natural ventilation at home and abroad, mainly focusing on the opening structure of buildings [10–14]. However, the utilization methods and control strategies of natural ventilation are different in different climatic regions. In the current research, the research on the impact of meteorological conditions on natural ventilation is not enough. This paper analyzes the natural ventilation of different layout house types by using the method of numerical simulation and combined with the climatic conditions in Anhui and discusses how to make full use of natural ventilation through the design of building layout in the design of residence, in order to provide a certain reference value for future architectural design.

In buildings, the use of natural ventilation is an important technical measure to reduce air conditioning energy consumption and improve indoor air quality. Reasonable natural ventilation organization can effectively adjust the air distribution and temperature distribution in the building and has an obvious effect on changing the satisfaction of indoor thermal environment. However, because the realization of natural ventilation is a passive method that depends on architectural design, its application effect largely depends on the design effects such as architectural orientation and plane layout. Good architectural design helps to enhance the effect of indoor natural ventilation. At the same time, the differences in architectural design will also have a great impact on the effect of architectural ventilation. The simulation method can provide objective guidance for architectural designers in the application of building natural ventilation strategy. Therefore, natural ventilation simulation is an effective auxiliary means in green building design. The details of building ventilation structure have a great impact on the effect of natural ventilation. For example, different positions of openings will affect the distribution of indoor air flow field. At the same time, the overhanging size of window cornice, the opening mode and angle of window sash, and the form of external shading in green buildings also have a great impact on natural ventilation. Therefore, we should comprehensively consider the comprehensive effect of various green building technologies, and we cannot ignore one and lose the other. For green buildings, natural

ventilation should be carefully considered in the whole process from planning, single building design to structural design, so as to ensure good indoor air quality and comfortable thermal environment and save nonrenewable resources.

This paper will simulate and analyze the impact of different house types on natural ventilation through CFD technology. The overall design scheme is as follows.

Turn the actual problem into a physical model to simulate the natural ventilation of the building plane problem.

Using CFD technology to simulate the working conditions, the velocity vector distribution, velocity size distribution, temperature distribution, and air age distribution of two different plane layouts are obtained, and the data obtained by the two physical models are compared and analyzed.

Summarize the impact of building plane layout on indoor natural ventilation, and put forward reasonable suggestions for building energy conservation of natural ventilation in plane layout.

3. Establishment of Ventilation Environment Physical Model Based on Aesthetic Optimization

Natural ventilation relies on the elegance caused by wind and the thermal pressure caused by the temperature difference between indoor and outdoor air to promote air flow and make the indoor and outdoor air exchange of buildings. So as to ensure the indoor fresh air of the building, take away the excess heat, and do not need energy consumption. It can save energy, equipment investment, and operation cost. It is an economic and effective ventilation method. The role of natural ventilation and the impact of ventilation on the dry building environment are mainly reflected in the following two aspects: first, the hygienic and healthy air quality. Generally speaking, the room is a relatively closed space. In addition, there are many indoor pollution sources, so the indoor pollutant concentration is 2–5 times higher than that outdoors, and the serious is dozens of times higher, Therefore, if it is not diluted, it will seriously affect the health of residents, and indoor ventilation is a very simple and effective purification method. It not only provides fresh air to ensure oxygen supply, but also eliminates indoor pollutants and greatly reduces indoor microbial density. Second, a comfortable living environment and low energy consumption. Natural ventilation is one of the main means of passive energy conservation. In summer, it can effectively eliminate indoor heat through ventilation and maintain a relatively comfortable indoor environment on the premise of no energy consumption. The residential plane design should clearly consider the air convection channel of each house type, especially the design of single direction house type, and corresponding measures must be taken: ensure sufficient area of openable windows; the width of ventilation and daylighting window shall not be less than 1.2 m; the location of toilet and kitchen shall be combined with indoor air channel to prevent mutual pollution; control the generation of excessive deep architectural grooves; when considering the ventilation problem inside the house, we should refer to the external environment of the building. Third, indoor details. Some indoor details are also important factors affecting residential ventilation quality. Some small designs can effectively improve the final effect. For example, the design of the exhaust shaft in the toilet and kitchen is very important. First of all, its location should be reasonably arranged. Unreasonable location may lead to ineffective ventilation. If the exhaust shaft is set at the door of the toilet, it will not be able to form effective ventilation inside the toilet. The traditional design idea is to set floor drains in the toilet and kitchen, but too many floor drains will not increase convenience, but will become the source of indoor air pollution. Because the floor drain is connected with the sewage pipe, the internal air is quite dirty. When the water seal of the floor drain evaporates, the dirty air will enter the room through the floor drain and pollute the indoor air, forming a source of disease. Therefore, the kitchen should cancel the floor drain, the bathroom should separate dry and wet, and the dry area should also cancel the floor drain, so as to completely eliminate the source of pollution. In addition, when selecting the external window, try to select the external window with multiple opening modes, so as to achieve the purpose of opening the window for ventilation under different external climatic conditions.

Psychological experiments show that beautiful visual works will stimulate specific activities in the medial prefrontal brain area, and beautiful and ugly pictures will activate different motor cortex [15]. In particular, the complex design with medium visual arousal is most likely to arouse people's aesthetic preference [16]. People prefer beautiful graphics [17]. Two representative house types are selected from the popular house type map of a large real estate development enterprise in China in recent years. Among them, house type A is the preferred house type with higher aesthetic evaluation points, and house type B is the general house type with lower aesthetic evaluation points. Aiming at the indoor ventilation effect of the above house type building layout, the numerical simulation analysis method of CFD (Computational Fluid Dynamics) is used to simulate it. CFD software is used to analyze, calculate, and predict the flow field. CFD technology can simulate various complex environments to save a lot of human, material, and financial resources. The simulation results are accurate and instructive. CFD technology has been widely used in aerospace, biomedicine, electronic technology, environmental pollution, and other fields [18–24].

(1) House type A (the preferred house type with higher aesthetic evaluation points): all units in the house type are square in shape, without obvious lack of corners or convex corners. Founder graphics are symmetrical graphics. People can know the situation of the other half when they see half of them. It is much easier to recognize symmetrical graphics than asymmetric graphics [25]. The master bedroom and secondary bedroom are distributed in the south. The living room is arranged between the two bedrooms,

and the doors and windows are staggered. The main air flow is collected in the living room and discharged from the balcony.

(2) House type B (the general house type with low aesthetic evaluation point): the house type is narrow and long as a whole. The secondary bedroom and toilet are located in the north, and the master bedroom and balcony are located in the south. Due to the indoor layout, the air flow will form a certain turning point, and the balcony and master bedroom are connected, resulting in a large air flow in the master bedroom.

3.1. Physical Model Establishment. The research objects are type A and type B house types. Now Airpak is used to establish the physical model. The geometric dimensions of the house type are established according to the actual dimensions. Among them, the furniture that has a great impact on the air distribution, such as bed, wardrobe, bedside table, and table, is established according to the actual dimensions. The specific model drawing and furniture size are shown in Figures 1 and 2 and Tables 1 and 2, respectively.

3.2. Determination of Boundary Conditions. In order to determine the indoor air flow state, it is assumed that all doors and windows are in the open state and the whole room is in the natural ventilation state during the simulation calculation of this example. Therefore, the characteristics of this example are obtained: diffusion term is equal to zero, steady flow, turbulent flow without component transport. In order to accurately simulate the gas flow state in the bedroom under ventilation, this example adopts the indoor zero equation model, the finite volume method, and the non-uniform grid to divide the whole area into many units. The differential equation is discretized into algebraic equations, and the variables are substituted into the unit body for calculation. The simple algorithm is adopted, and the discretization format is the first-order upwind format [26].

3.3. Meshing. The bedroom of house type A is rectangular as a whole. In order to divide the whole grid evenly and accurately respond to the calculation model, the following is taken first:

The maximum dimension in the x-axis direction is Max X size = 0.2.

The maximum dimension in the y-axis direction is Max Y size = 0.15.

The maximum dimension in the z-axis direction is Max Z size = 0.2.

The part with local objects is locally encrypted, and the encrypted part is 5 times that of the original grid. The simulation results are divided into 70650 grids and 78409 nodes.

The grid calculation of house type A is shown in Figure 3.

The bedroom of house type B is an irregular rectangle. In order to divide the whole grid evenly and accurately respond to the calculation model, the following is taken first:

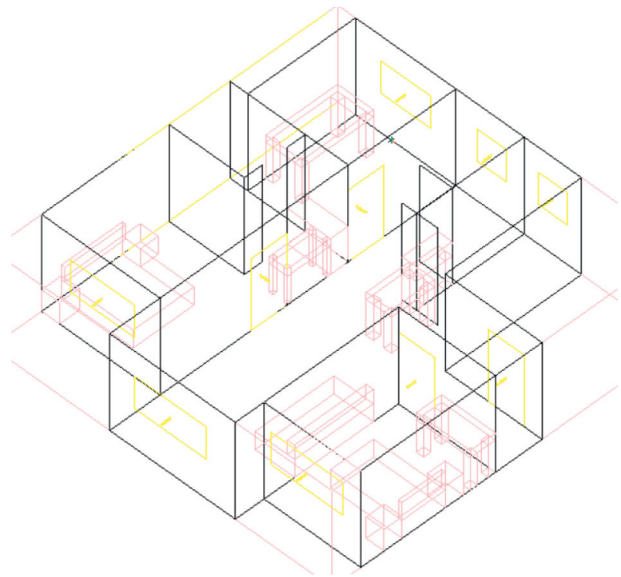

Figure 1: Model of house type A.

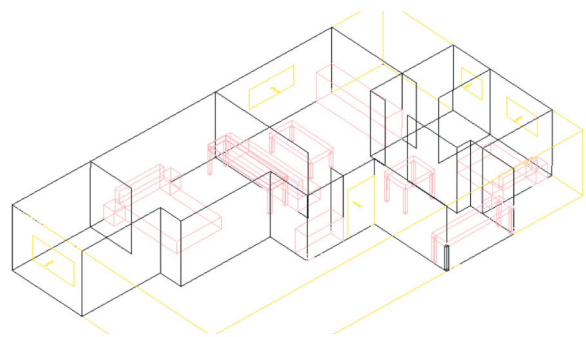

Figure 2: Model of house type B.

Table 1: Size table of type A furniture.

Serial number	Name	Size mm
1	Table	1500 × 1000 × 1200
2	Second bed rest	2500 × 1800 × 500
3	Sofa	3500 × 1200 × 600
4	Master bed	2800 × 2000 × 500
5	Desk	2000 × 1000 × 800
6	Windows	1800 × 900
7	Door	2000 × 1000
8	Shoe cabinet	1600 × 800 × 1200

Table 2: Size table of type B furniture.

Serial number	Name	Size (mm)
1	Table	1300 × 1000 × 1200
2	Second bed rest	2000 × 1800 × 500
3	Sofa	3500 × 1000 × 600
4	Master bed	2500 × 2000 × 500
5	Desk	1200 × 500 × 800
6	Windows	1800 × 900
7	Door	2000 × 1000

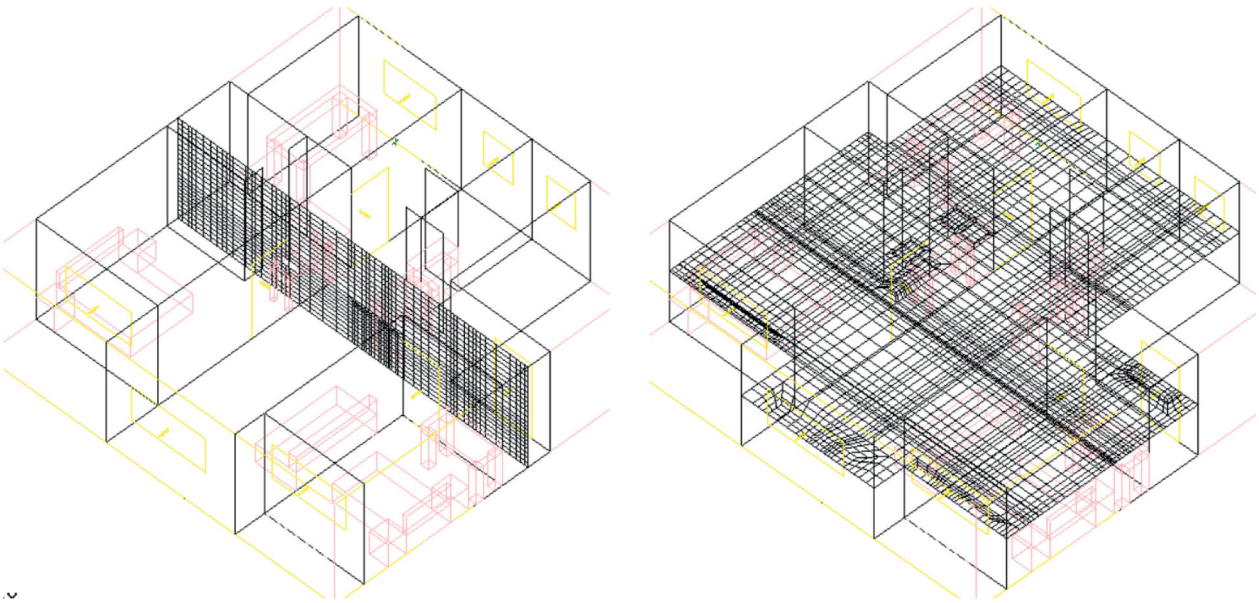

Figure 3: Grid division of house type A along the (a) X axis and (b) Y axis.

The maximum dimension in the x-axis direction is Max X size = 0.15.

The maximum dimension in the y-axis direction is Max Y size = 0.10.

The maximum dimension in the z-axis direction is Max Z size = 0.15.

The part with local objects is locally encrypted, and the encrypted part is 5 times that of the original grid. The simulation results are divided into 123277 grids and 135653 nodes.

The grid calculation of house type B is shown in Figure 4.

3.4. Determination under Different Working Conditions. In most parts of China, especially in the eastern region, the wind direction is different in winter and summer. In winter, there is more northwest wind or northerly wind, and in summer, there is more southeast wind or southerly wind. Based on this, this paper simulates two working conditions and compares and analyzes the indoor natural ventilation effect of different house types under different working conditions.

Working condition 1: north wind 2.5 m/s, ambient temperature 15°C, indoor initial temperature 20°C

Working condition 2: south wind 3.5 m/s, ambient temperature 20°C, indoor initial temperature 25°C

4. Simulation Analysis of Condition 1

4.1. Velocity Vector Distribution under Condition 1. According to the above, the parameters determined in condition 1 are north wind 2.5 m/s, ambient temperature 15°C, and indoor initial temperature 20°C. A and B are simulated, respectively.

Figure 5 shows the velocity vector distribution of house types A and B under condition 1. It can be seen from the figure that, except for less air distribution in the secondary toilet, the overall air diffusion in other spaces of house type A is uniform. The air distribution of living room, master bedroom, and secondary bedroom is uniform and stable. For house type B, because the house type is long and narrow and there is only one air outlet in the south, the air flow is obvious from the living room to the main bedroom. The air distribution of house type A is obviously better than that of house type B.

4.2. Velocity Distribution under Condition 1. Figure 6 shows the speed distribution of house types A and B under condition 1. It can be seen from the figure that, in house type A, in the main bedroom, secondary bedroom, and living room with frequent personnel activities, the wind speed distribution is uniform and appropriate. Take the speed of the geometric center of the space as the average wind speed, the average wind speed of the main bedroom is about 0.6 m/s, the average wind speed of the secondary bedroom is about 0.5 m/s, and the average wind speed of the living room is about 0.8 m/s. In house type B, because there is only one window in the south, the wind speed on the passage from the living room to the master bedroom is significantly increased, and the average wind speed of the master bedroom is about 2.5 m/s.

4.3. Temperature Distribution under Condition 1. Natural ventilation can reduce the indoor temperature. As can be seen from Figure 7, under condition 1, the temperature of house A is evenly distributed as a whole. For the master bedroom and secondary bedroom with frequent personnel activities, the value of the geometric center of the space is taken as the average value. The average temperature of the master bedroom is 12.5°C, the average temperature of the secondary bedroom is 11°C, and the average temperature of

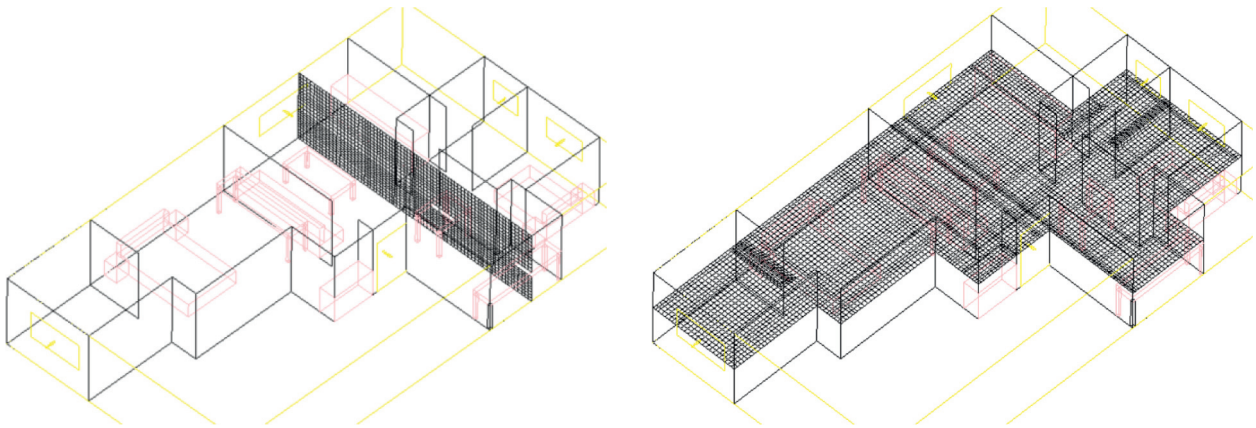

Figure 4: Grid division of house type B along the (a) X axis and (b) Y axis.

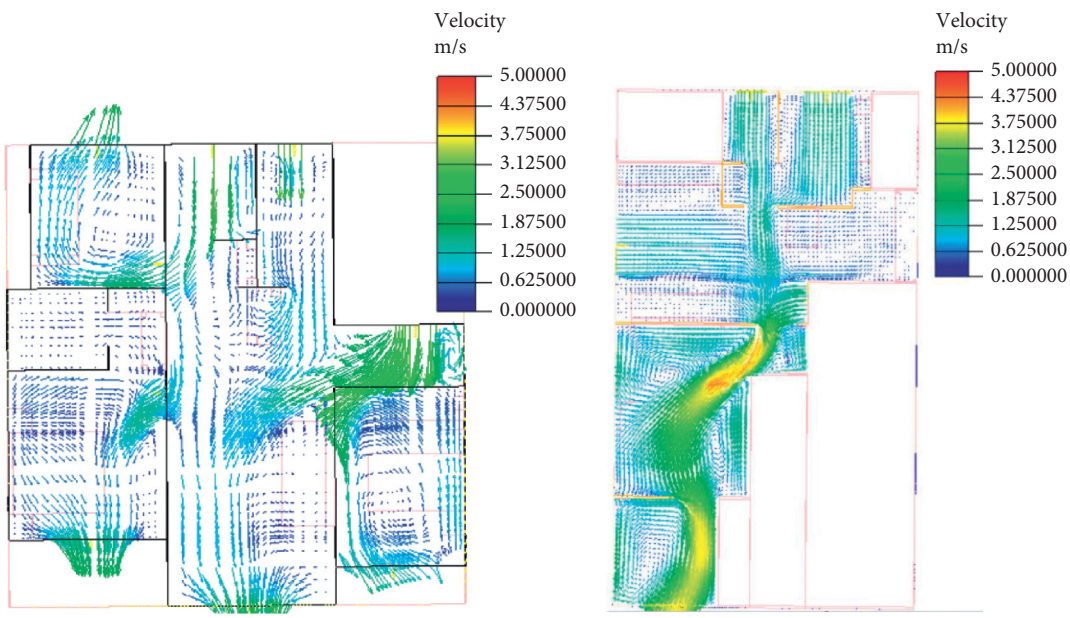

Figure 5: Velocity vector distribution of two house types A and B under condition 1.

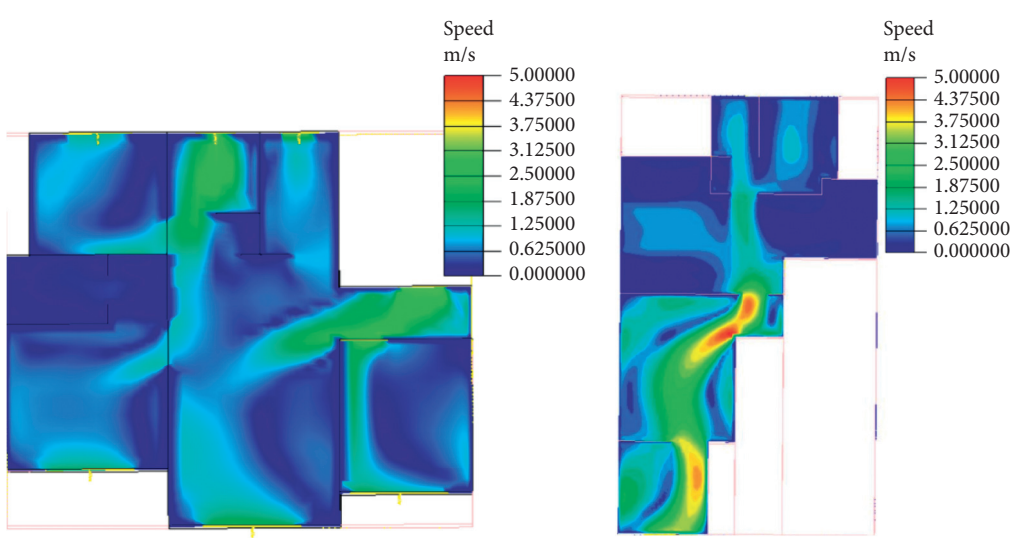

Figure 6: Speed distribution of two house types A and B under condition 1.

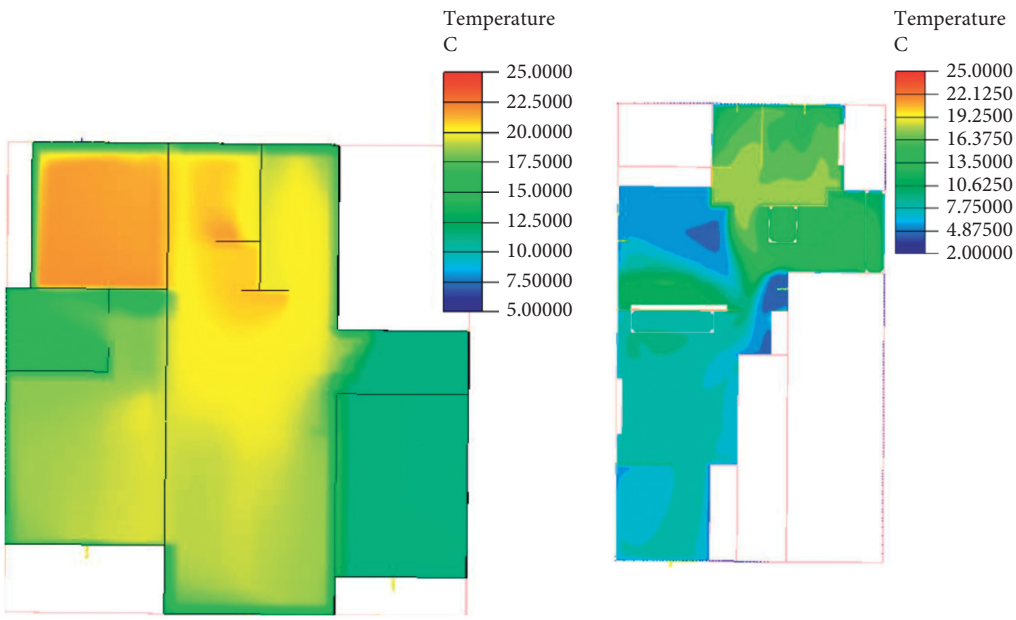

Figure 7: Temperature distribution of two house types A and B under condition 1.

the living room is about 13°C. Due to the uniform distribution of air distribution, the temperature distribution of house type B varies greatly. The temperature in the living room and the south master bedroom is low. The average temperature in the living room is about 8°C and the average temperature in the master bedroom is about 7°C. In terms of temperature comfort, house type A is better than house type B.

4.4. Air Age Distribution under Condition 1. Air age refers to the time required to reach a certain point in the room from the air outlet of the room. The air age at this point refers to the average age of all micro air at this point. Therefore, the air age can reflect the freshness of the room air and the ability of the room to remove pollutants. The smaller the air age, the stronger the ability to remove pollutants.

It can be seen from Figure 8 that, in house type A, except for the secondary toilet, the air age of the rest is evenly distributed. Due to the poor air distribution in the toilet, the air age reaches about 100 seconds. The rest of the air age is evenly distributed. In house B, the air age in the kitchen area is about 100 seconds due to poor air organization. Due to the air passage between the living room and the master bedroom, the air age in the master bedroom is only about 20 seconds.

4.5. Summary of Condition 1. Under condition 1, the air distribution, temperature, and air age of house A and house B are analyzed, respectively. The air distribution of house A is uniform, and the temperature is relatively uniform. The air age is within a reasonable range, which can not only effectively remove indoor pollutants, but also maintain a certain comfort. Due to the overall layout and fewer windows, type B has large air distribution in some areas of the room, obvious temperature difference, and large air age. Although it can take away pollutants in the air, the overall comfort is poor.

5. Simulation Analysis of Condition 2

5.1. Velocity Vector Distribution under Condition 2. According to the above, the parameters determined in condition 2 are south wind 3.5 m/s, ambient temperature 20°C, and indoor initial temperature 25°C. A and B are simulated, respectively.

As can be seen from Figure 9, under condition 2, the overall air distribution of house A is uniform, in which the air enters the room from three windows in the south and is discharged from two windows in the north. Except for less air flow in the secondary toilet, the other air is evenly distributed. For house type B, the air enters from the south and west windows and exits from the north two windows. You can see an obvious air flow path from the master bedroom to the living room, and the velocity vector on the path is too large.

5.2. Velocity Distribution under Condition 2. As can be seen from Figure 10, the overall wind speed distribution of house A is relatively uniform. Take the value of the geometric center of the space as the average value, and the average wind speeds of the main bedroom and the secondary bedroom are 3.3 m/s and 3.4 m/s, respectively. The average wind speed in the living room is about 3.2 m/s. For house type B, it can be clearly seen that the wind speed is large on the wind road from the master bedroom to the living room, and the wind speed in other locations is significantly reduced.

5.3. Emperature Distribution under Condition 2. As can be seen from Figure 11, since the air distribution of house A is uniform and its temperature is also evenly distributed, under

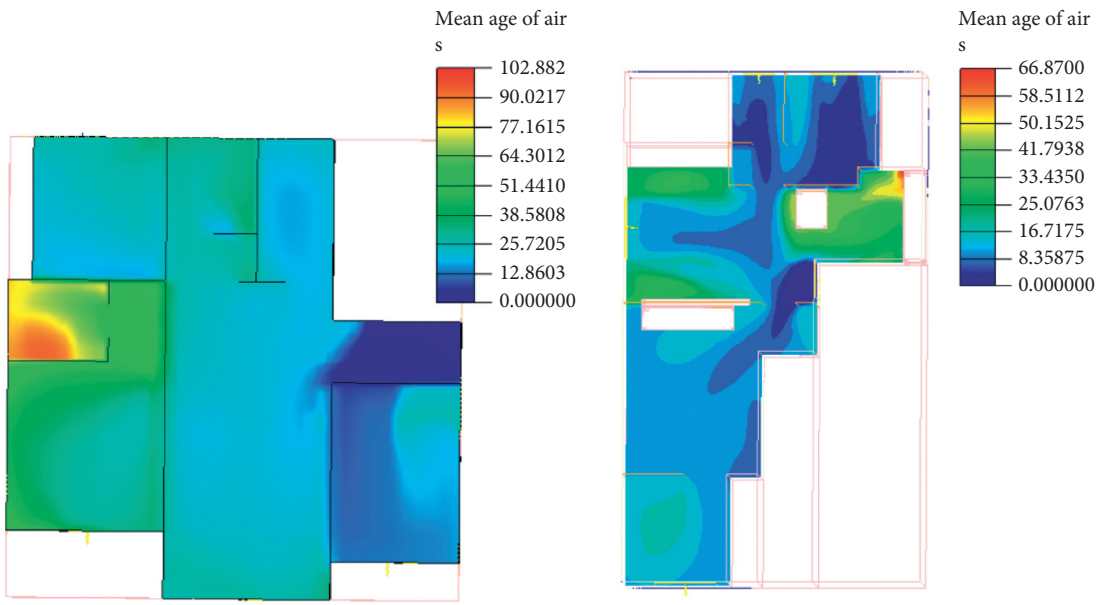

Figure 8: Air age distribution of two house types A and B under condition 1.

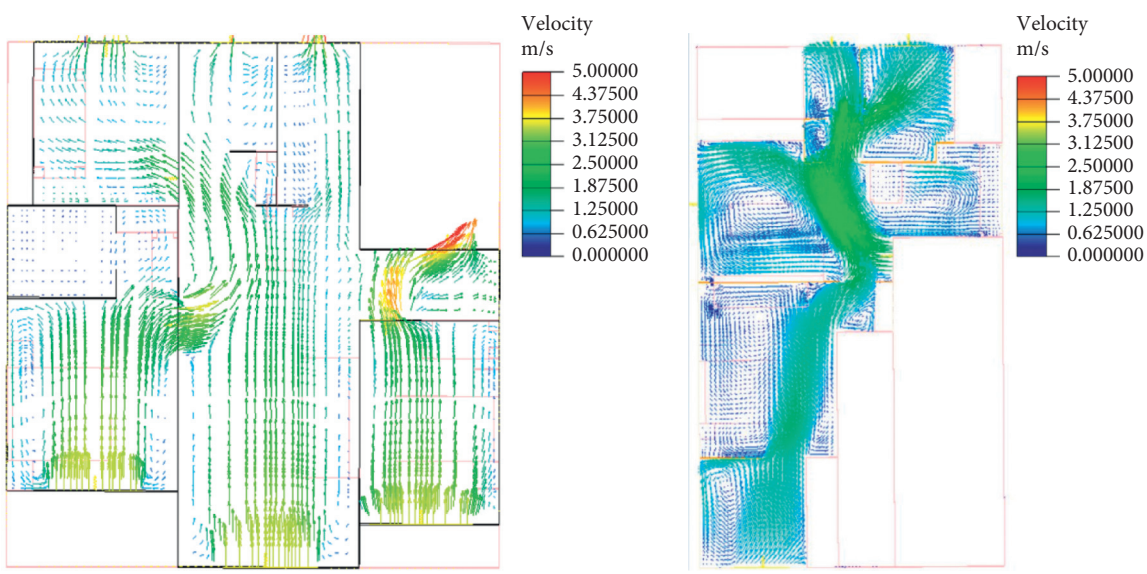

Figure 9: Velocity vector distribution of two house types A and B under condition 2.

condition 2, the average indoor temperature is about 19°C. Due to the ancient air distribution of house type B, the temperature in the north decreases significantly, and the temperature gradient changes significantly in the air flow path.

5.4. Air Age Distribution under Condition 2. It can be seen from Figure 12 that in house type A, except for the secondary toilet, the air age of the rest is evenly distributed. Due to the poor air distribution in the toilet, the air age reaches about 80 seconds. The rest of the air age is evenly distributed. In house B, due to the large wind speed on the air flow path of the master bedroom, a local vortex is formed at the foot of the wall of the master bedroom, resulting in the air age of the master bedroom being relatively large, and the air age is about 60s. For the same reason, a local small vortex is also formed in the living room and kitchen area, resulting in the air age of about 30s. On the whole, the air age distribution of house type A is uniform and comfortable.

5.5. Summary of Condition 2. Under condition 2, the air distribution, temperature, and air age of house A and house B are analyzed, respectively. Due to the house type and window position, the air distribution of house type A is

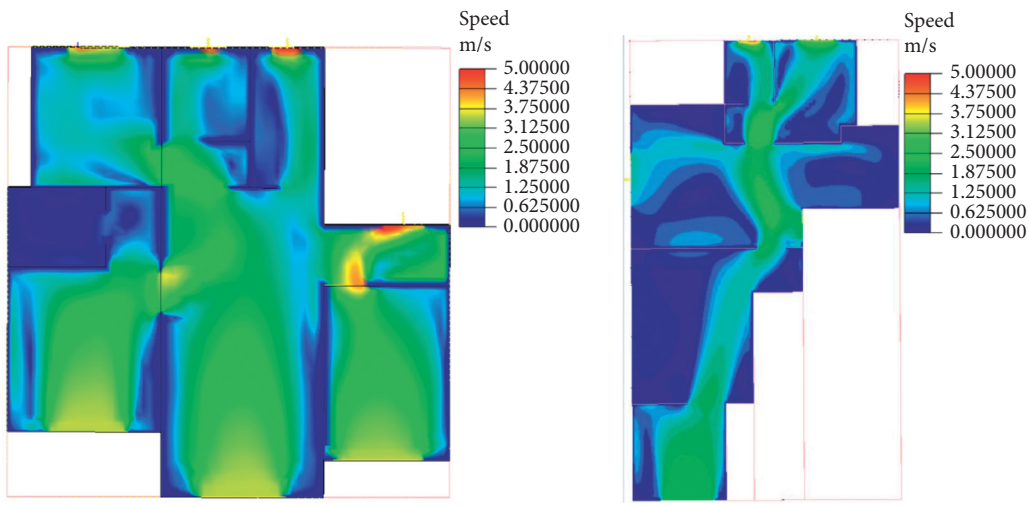

Figure 10: Speed distribution of two house types A and B under condition 2.

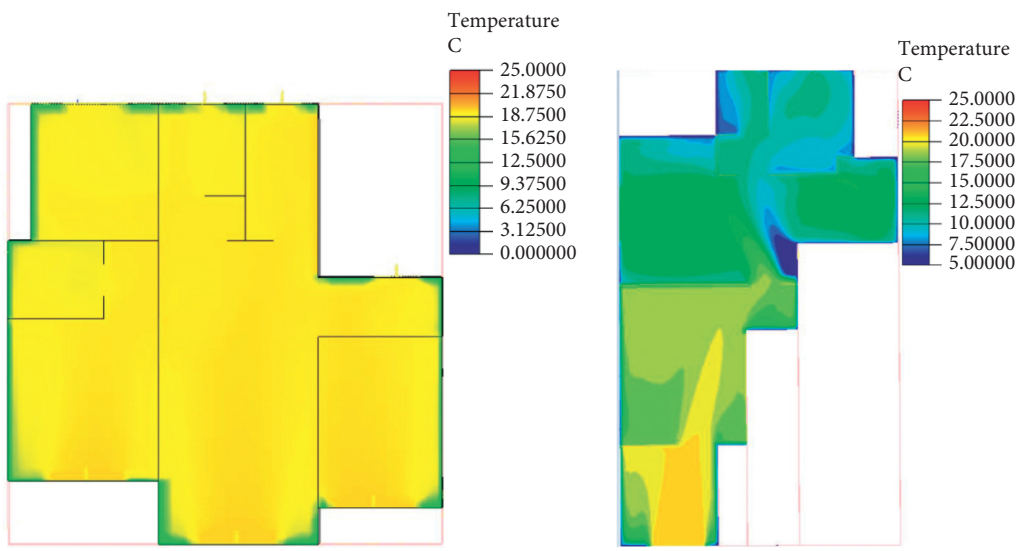

Figure 11: Temperature distribution of two house types A and B under condition 2.

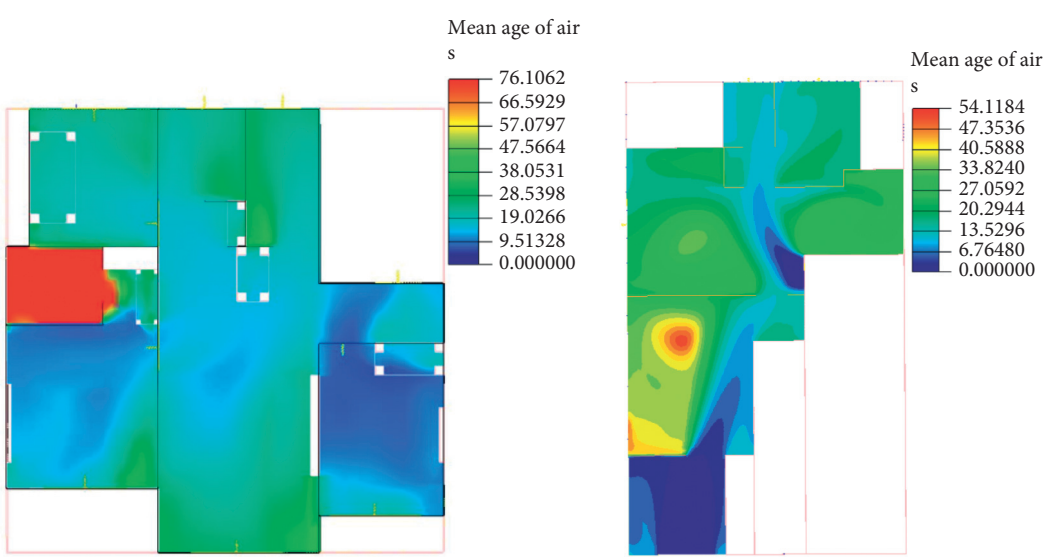

Figure 12: Air age distribution of two house types A and B under condition 2.

Table 3: Comparison of simulation results of two house types.

Working condition	House type	Velocity vector	Speed size	Temperature distribution	Air age distribution	Summary
Working condition 1North wind 2.5 m/s Ambient temperature 15°C Indoor initial temperature 20°C	House type A	The overall distribution is uniform, and only the air distribution in the secondary toilet is weak	The average wind speed in the master bedroom is about 0.6 m/s Secondary horizontal wind speed is about 0.5 m/s The average wind speed in the living room is about 0.8 m/s	The average temperature of the master bedroom is about 12.5°C The average temperature of the secondary bed is about 11°C The average temperature in the living room is about 13°C	Air age in toilet 100s, and the air age in other areas is relatively uniform, about 30s–50s	Under conditions 1 and 2, the air flow and temperature distribution of house a are relatively uniform, the air age is reasonable, it will not lead to the accumulation of pollutants, and the overall comfort is better than that of house B
	House type B	There is an obvious airflow path running through the house type from north to south, and the velocity vector on the airflow path is strong	The average wind speed in the master bedroom is about 2.5 m/s Secondary horizontal wind speed is about 0.4 m/s The average wind speed in the living room is about 2.3 m/s	The average temperature of the master bedroom is about 7°C The average temperature of the secondary bed is about 11°C The average temperature in the living room is about 8°C	Air age in kitchen 100s, the air age on the air flow path is about 15s–20s	
Working condition 2South wind 3.5 m/s Ambient temperature 20°C Indoor initial temperature 25°C	House type A	The overall air distribution is uniform	The average wind speed in the master bedroom is about 3.3 m/s Secondary horizontal wind speed is about 3.4 m/s The average wind speed in the living room is about 3.2 m/s	The average temperature of the master bedroom is about 17°C The average temperature of the secondary bed is about 18°C The average temperature in the living room is about 19°C	Air age in toilet 80s, the air age in other areas is relatively uniform, about 10s–25s	
	House type B	There is an obvious airflow path running through the north and south, and the speed on the path is moderate and strong	The average wind speed in the master bedroom is about 1.2 m/s Secondary horizontal wind speed is about 2.5 m/s The average wind speed in the living room is about 3.5 m/s	The average temperature of the master bedroom is about 18°C The average temperature of the secondary bed is about 15°C The average temperature in the living room is about 10°C	Master bedroom air age approx 60s, kitchen and living room air age is about 35s, and the air age distribution in other areas is uniform	

uniform, the temperature is also relatively uniform, and the air age is within a reasonable range, which can not only effectively remove indoor pollutants, but also maintain a certain comfort. For house type B, due to the long and narrow layout and few windows, there is an obvious air flow path from the master bedroom to the living room. On the air flow path, the wind is large, the temperature gradient is large, and the air age is small, which gives poor comfort to the human body. Therefore, house type A is better than house type B as a whole.

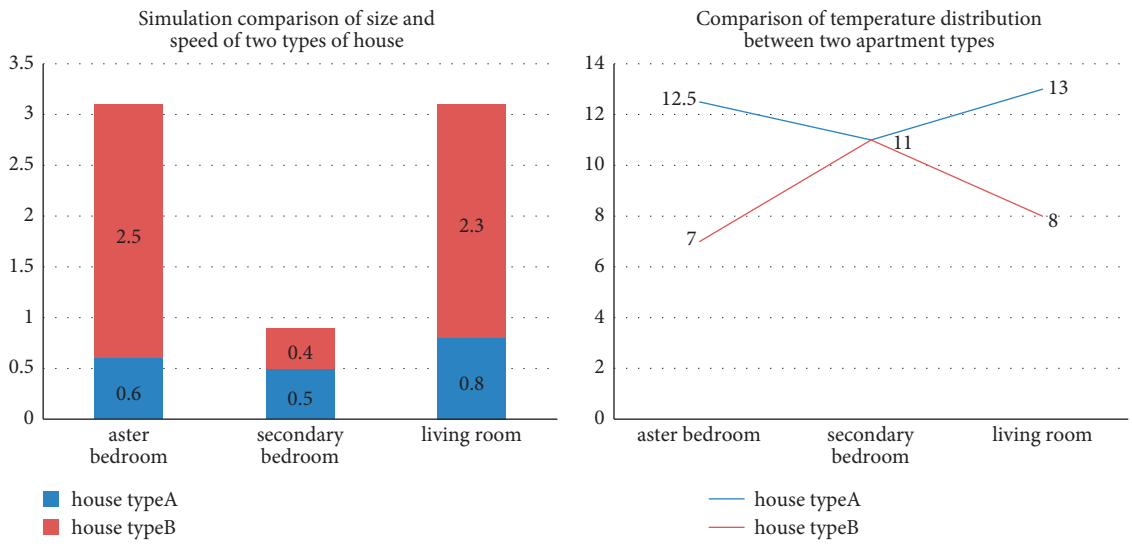

Figure 13: Condition 1: Comparison of speed and temperature distribution of two house types.

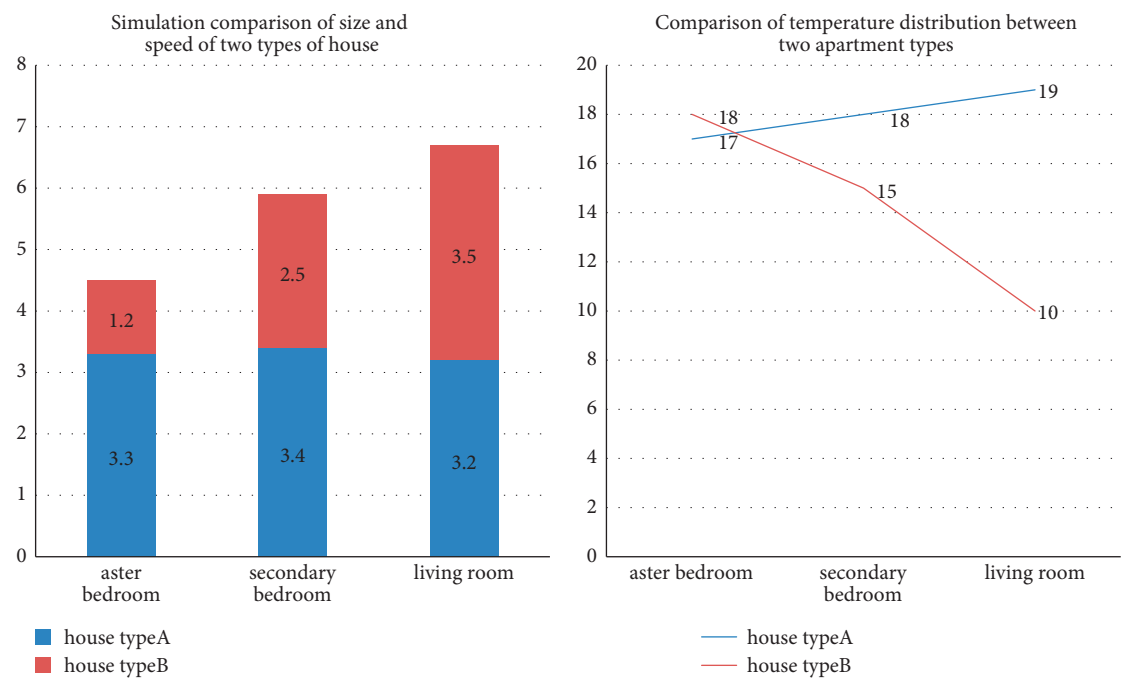

Figure 14: Condition 2: Comparison of speed and temperature distribution of two house types.

6. Conclusion

According to the above simulation analysis of house types A and B under different working conditions, the analysis summary table is obtained. See Table 3 for details.

According to the above methods, the following conclusions are drawn by comparing the simulation analysis of other house types under different working conditions (Figures 13 and 14).

If the house type is square (the room is square, and the streamline interference degree, the view, the scene, and the facade are flat), the internal partition wall will hinder the air flow organization, affect the air flow distribution, and change the air flow direction. Reasonable indoor layout makes it easier to form uniform air distribution and temperature distribution and enhance indoor comfort.

In the same house type plane, the selection of building orientation has a significant impact on the effect of indoor natural ventilation. Select an appropriate building orientation, so that the main openings of the building are located at reasonable positive and negative pressure positions under the condition of natural ventilation, and an organized and effective air inlet and outlet will form a good air flow field in the building, which is more conducive to natural ventilation under the same conditions.

Narrow and long house type, such as house type B, is more likely to form ventilation, and the wind speed and air volume on the air flow path are larger. However, local vortices will be formed at some locations, forming air flow dead corners, resulting in the accumulation of pollutants; some areas need mechanical ventilation to maintain air quality.

For the hall house type, due to the overall squareness and large opening rate of the building, the indoor air distribution and temperature distribution will be uniform, and the human body will feel more comfortable.

Therefore, when improving the design of natural ventilation for poorly ventilated houses, it is necessary to guide the air distribution and improve the indoor air quality according to the design of plane layout. For different house types, the number of external windows in the house type room can be reasonably increased or reduced to improve the indoor ventilation effect.

Among the buildings in China, building plane layout can effectively provide building users with a healthy and comfortable environment, which is an important idea of sustainable development.

At present, people attach great importance to environmental protection and energy conservation. The adoption of reasonable building plane layout is of great significance to reduce carbon emissions.

With the rapid development of green environmental protection and the further improvement of people's requirements for indoor air quality, the impact of building plane layout on natural ventilation will be paid more attention.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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