The Application of the Computer Information Technology to the Indoor Microclimate Optimization

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Abstract. Along with development of computer technology, the method of computer numerical simulation plays more and more important role in the area of architecture design. In order to improve the building's energy-saving, comfortable and healthy indoor microclimate environment, the project has carried out indoor renovation and optimization design with computer numerical simulation technology according to the existing problems of the office building. By comparing the computer simulation results of ventilation, air age, thermal comfort PMV and indoor light environment before and after the renovation, the architectural interior design scheme was optimized. The indoor microclimate environment of the optimized scheme was conducive to human health and comfort. In order to obtain good indoor air quality and thermal environment, the computer simulation analysis method of the indoor thermal environment used in the reconstruction of existing buildings was feasible and effective.

Keywords: The indoor microclimate · Thermal environment · Computer technology

1 Introduction

Indoor microclimate refers to the climate of people's small environment, which is mainly reflected in the impact on environmental comfort. Its main factors are indoor temperature, indoor air humidity, wind speed and so on [1].

Indoor microclimate not only affects human comfort and health, but also has a significant impact on the work efficiency of indoor personnel. A good indoor microclimate can make people feel refreshed, energetic and happy.

The indoor space renovation of the building adopted the method of computer simulation analysis, carried out scheme analysis and comparative evaluation from the perspective of indoor microclimate, and put forward the design ideas and solutions in the process of indoor renovation, so as to provide experience and reference for the indoor renovation of office buildings.

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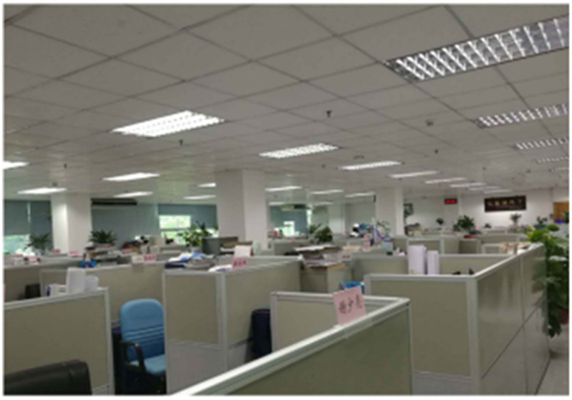

Fig. 1. Original office space layout

2 Research Object

The project was an office building of a university in Shenzhen, with a total construction area of 500 m^2, 6 floors and a height of 3.6 m. The renovation was aimed at the local office space on the third floor, and the building functional area mainly includes leadership office area and full-time teacher area. Before the renovation, the teacher's office adopted a large space layout without separation and noisy environment, as shown in Fig. 1. The indoor ventilation was poor, some locations need to use wind deflectors for wind protection, and some locations need to turn on fans for ventilation. The glare pollution of office seat near the window was serious, while the use of sunshade will lead to insufficient indoor natural lighting.

In order to improve the building energy-saving, comfortable and healthy indoor microclimate environment, the project had carried out indoor renovation and optimization design according to the existing problems in the office area.

3 Method

3.1 Simulation Software

In order to improve the indoor office environment, the project optimized the indoor renovation scheme according to the indoor microclimate. The building ventilation environment, air age, thermal comfort PMV, natural daylighting and glare environment were simulated with the Green building software (gard2020). Compared the indoor microclimate environment before and after building renovation, the Interior design was optimized.

Green building software (gard2020), developed by Beijing Green Building Software Company, was a professional green building simulation software based on AutoCAD platform. The software includes energy-saving calculation module BECS, daylighting calculation module DALI, ventilation calculation module VENT, thermal environment calculation module TEAR and so on. The simulation results were accurate and effective, and can be used in architectural design and renovation.

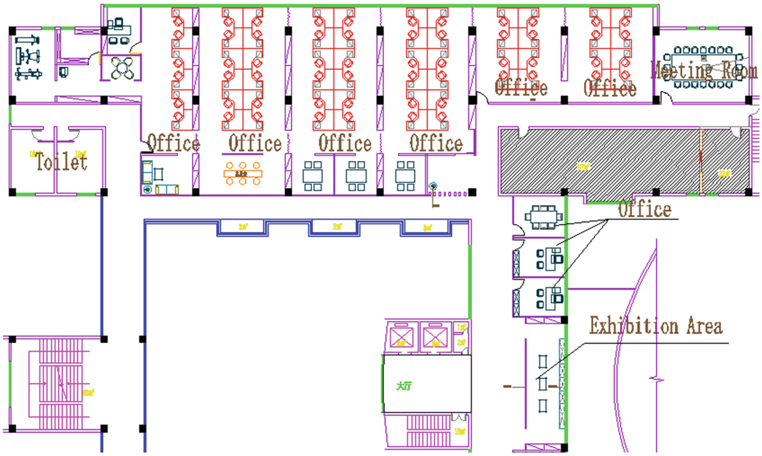

Fig. 2. Optimized scheme layout

3.2 Simulated Cases

In transition season, the staff of university offices often open windows and doors for natural ventilation, which can effectively improve indoor ventilation and thermal environment. Therefore, window opening is adopted for wind environment, air age, PMV index, indoor daylighting and glare simulation. The optimized interior design scheme was shown in Fig. 2.

4 Results and Discussions

4.1 Building Ventilation Environment

The dominant wind speed in Shenzhen was 2.70 m/s with the wind direction southeast. In the simulation, the inlet boundary wind speed was set by gradient wind, and the free outflow was used as the outlet boundary condition. During indoor ventilation environment evaluation, the area with wind speed less than 0.2 m/s was considered as windless area [2].

The indoor ventilation environment for 1.5 m simulation results before and after building renovation were shown in Fig. 3.

It can be seen from Fig. 3 that before the building reconstruction, the indoor air environment was poor. At node 1, the peculiar smell of the toilet rushed into the room. At node 2, the wind speed of large space office was uneven, and the areas with wind speed greater than 0.2 m/s were concentrated on the right side and aisle, and the indoor lighting and air conditioning control were not energy-saving and not conducive to management. At node 3, the exterior glass curtain wall had small opening area, and there were many air conditioners outdoor for heat dissipation, which lead to poor ventilation and indoor heat gain. At node 4, there was a spare room nearby, which was not effectively utilized.

After the building interior design optimization, the indoor ventilation environment was improved. At node 1, the door was designed at the end of the corridor and far from

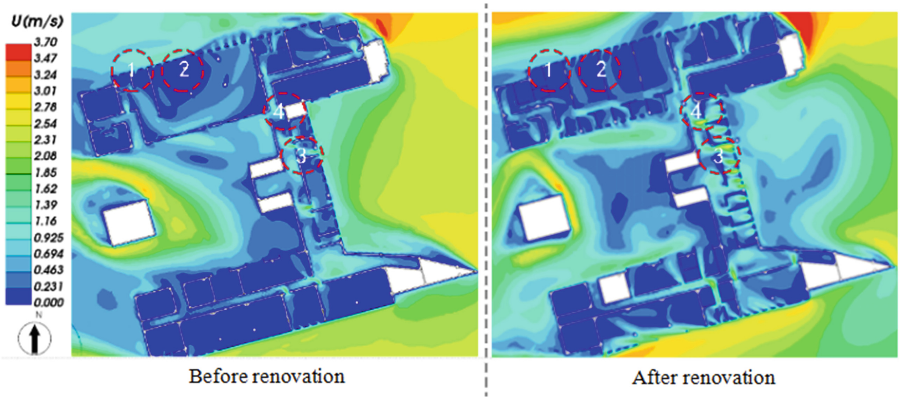

Fig. 3. Ventilation vector diagram of the building

the toilet to prevent the strange smell from flowing into the indoor office area. Moreover, the door was in the upwind direction, which can promote indoor ventilation with the North outward window.

At node 2, the large space was divided into small spaces. First, the air flow can be organized into each space. The indoor office area can obtain good ventilation. Automatic doors were set between small spaces, which were independent of each other, so as to realize the zoning control of lighting and air conditioning. Node 3 was designed as a semi closed display area, to enhance air flow and disperse outdoor hot air flow. The original space node 4 was recombined in order to make use of the space, and the indoor wind speed was also greatly improved.

4.2 Air Age

The small space node 2 separated by large space and node 4 were selected for air age research, as shown in Fig. 4. The simulation results before and after renovation was shown in Fig. 5.

As can be seen from Fig. 5, the air age in the middle area of node 2 before renovation was poor. After the renovation, the ventilation was enhanced and the air age was increased by 90% compared with that before the renovation. After space combination, the air age of node 4 was 50% higher than that before renovation.

4.3 Indoor Thermal Comfort Index PMV

In 1984, the international organization for standardization put forward a new standardized method for indoor thermal environment evaluation and measurement standard ISO7730 [3], and PMV-PPD index was used to describe and evaluate the indoor thermal environment. The PMV had 7 division grades, and the PMV-PPD index value between −0.5 and +0.5 was considered to be comfortable [4].

The small space node 2 separated by large space and node 4 were selected for Indoor thermal comfort research, as shown in Fig. 4. The PMV simulation results before and after renovation was shown in Fig. 6.

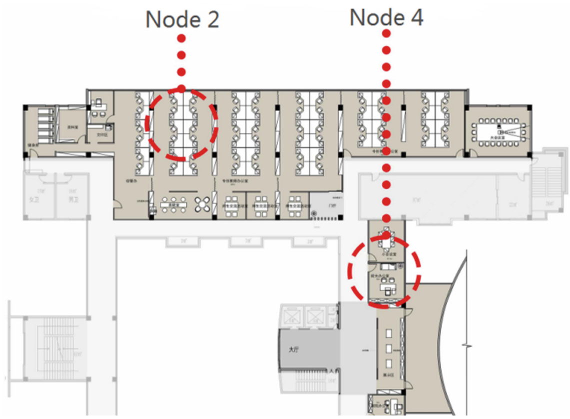

Fig. 4. Optimized plan (Note: dark gray area was the renovation area)

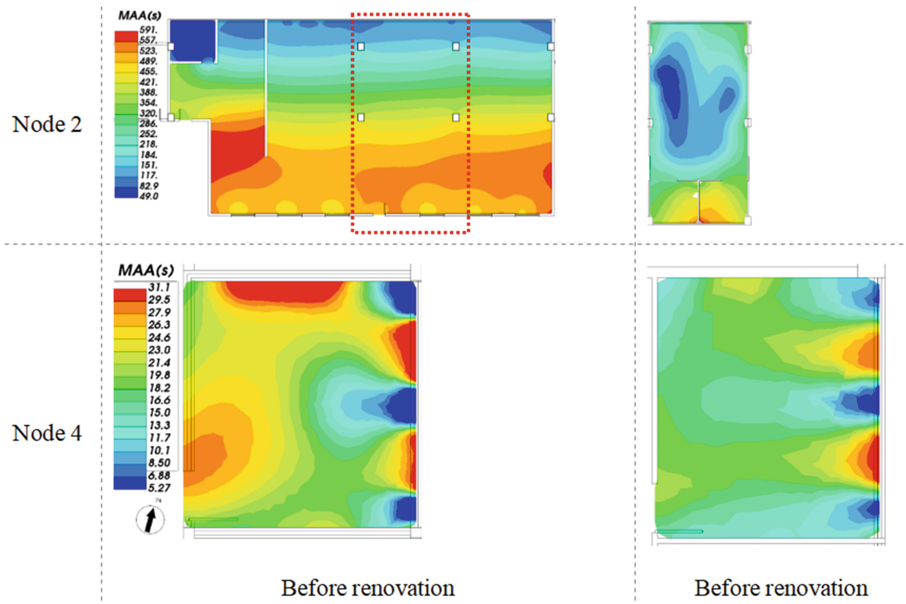

Fig. 5. Air age diagram of the building

Figure 6 shows that after renovation, the good thermal comfort areas for node 2 and 4 increased by 92% and 33% respectively compared to before. Indoor thermal comfort has been fully improved.

4.4 Indoor Daylight Environment

The indoor daylight environment of the building was modeled with Dali, and the radiance program core was used for simulation calculation.

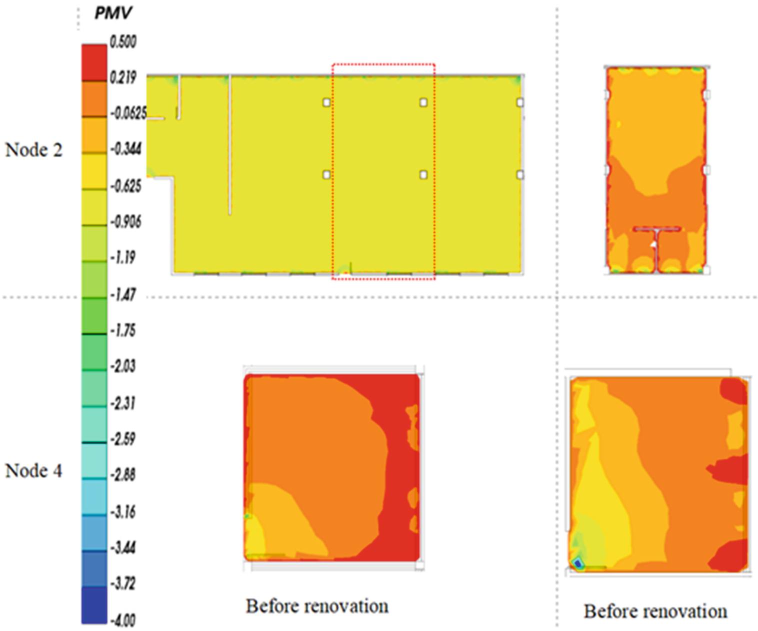

Fig. 6. The PMV simulation diagram of the building

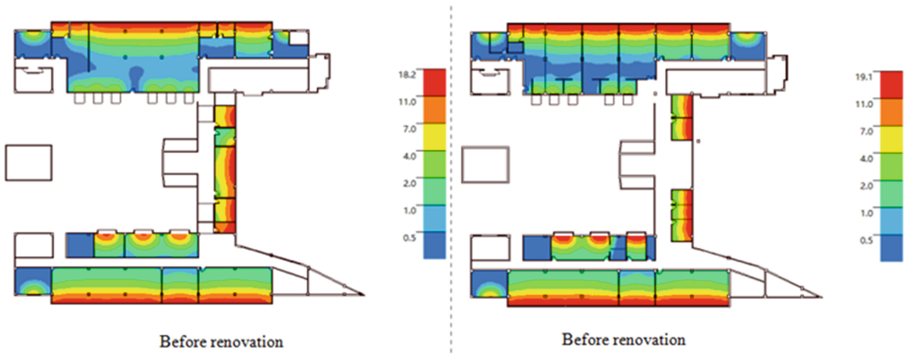

Fig. 7. Indoor daylight factor of the building

The simulation results were shown in Fig. 7. The area of rooms meeting the lighting requirements after the building reconstruction had increased by 6% than that of before reconstruction.

4.5 The Discomfortable Glare

The discomfortable glare was an important index to evaluate the daylighting quality. In the evaluation of green buildings, it was also required to have reasonable measures to control the glare of the main functional rooms. The discomfortable glare index (DGI) of external windows of buildings in Shenzhen should not exceed 27 [5]. It was simulated with the software Dali. The simulation results showed that the indoor uncomfortable glare after the building renovation was significantly reduced by 11% compared to before.

5 Conclusions

The indoor microclimate environment of office building before and after the renovation was simulated and analyzed in this paper.

By comparing the results of ventilation, air age, thermal comfort PMV and indoor light environment before and after the renovation, the architectural interior design scheme was optimized. The indoor microclimate environment of the optimized scheme was conducive to human health and comfort. In order to obtain good indoor air quality and thermal environment, indoor microclimate ennvironment simulation analysis method used in the reconstruction of existing buildings was feasible and effective.

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