Scholars Journal of Engineering and Technology (SJET) **ISSN 2321-435X (Online)**
Sch. J. Eng. Tech., 2015; 3(4C):487-493 **ISSN 2347-9523 (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublisher.com

Research Article

Application case of natural ventilation and passive energy saving based on new national green building standards

Xue Ting
College of civil engineering and architectural engineering, Northeast Petroleum University, China

***Corresponding author**
Xue Ting
Email: 526244396@qq.com

Abstract: According to the requirements of GB/T 50378-2014, the simulation and optimizing about outdoor wind environment and indoor natural ventilation of one hotel in Inner Mongolia are made in this paper. And according to the simulation results, the outdoor wind environment andindoor natural ventilation of the building are scored with the relevant items. This paper provided some reference for practical use about the simulation of outdoor and indoor wind environment in green building project.
Keywords: green building, the simulation and optimizing; outdoor wind environment; indoor natural ventilation

INTRODUCTION

Assessment standard for green building [1] GB/T 50378-2014 was put into implementation on January 1st, 2015, and it marks that rapid development of the green building industry begins.In general, green building puts forward higher requirements to building design, and what bothers the designers most is the provisions related to the simulated calculation, especially the simulated calculation relevant to the outdoor wind environment and indoor natural ventilation.

As a kind of passive technology, passive ventilation has been applied more and more extensively in green building industry. When there is stronger incoming flow, heavy winds may occur in some areas around the buildings; In case that the strong wind region locates in the building entrance, passage, terrace and some areas where pedestrians use frequently, the pedestrians may feel uncomfortable, even get hurt, thus there will be serious wind environment problems. Under normal climate conditions, the problems will influence the microclimate and comfort of city environment directly. Once there is a gale, this kind of influence can even turn into a disaster, it may partly damage the glass curtain wall on the exterior walls, sash, canopy, and cause safety threats both indoor and outdoor. Therefore, during the design phase of green building, assessment of the outdoor wind environment should be carried out, also the designers should analysis the influence of building location relationship on the outdoor wind environment.

Meanwhile, the outdoor wind environment profoundly affects the indoor wind environment of the buildings, especially it will influence the wind protecting of building and natural ventilation decisively. Wind protecting of building in winter can reduce the permeating airflow effectively, decrease heating energy consumption. And in summer and transition season, natural ventilation can reduce air-conditioning energy consumption.

The influence of outdoor wind field and wind environment on indoor environment is mainly taken into consideration in the simulation analysis.

PROJECT OVERVIEW

In this paper we take one hotel project in Inner Mongolia as an example and introduce practical application of green building wind environment simulated calculation for public buildings. This project is located in Inner Mongolia, Chifeng city. Total construction area of this project is about 50000 square meters, and there are 20 floors for the over ground part, total height of the building is 97.6m, most of the surrounding buildings are multistory and high-rise buildings. The effect picture is shown below-Fig-1.

Fig-1: Effect picture of the project

Simulation and Optimization of Outdoor Wind Environment

Requirements of the items

Item 4.2.6 in [1] GB/T 50378-2014 mainly describes the requirements of outdoor wind environment, the details are as follows:

4.2.6 For the field wind environment, it should be convenient for walking outside and comfortable activities, and there should be natural ventilation for the buildings. Total score for the assessment is 6, the score can be graded and added up according to the following rules:

1 Under the condition of typical wind speed and wind direction in winter, grade and add up the score according to the following rules:

1) Wind speed in the pedestrian area around the buildings is under 5m/s, and outdoor wind speed amplification coefficient is less than 2, score 2 points.

2) Except the first row of buildings facing the wind, the wind pressure difference between the windward side and leeward side of the building is less than 5Pa, score 1 point.

2 Under the condition of typical wind speed and wind direction in summer and transition season, grade and add up the score according to the following rules:

1) There is no eddy and calm zone in the activities area, score 2 points.

2) For more than 50% of the operable windows, wind pressure difference between indoor and outdoor is larger than 0.5Pa, score 1 point.

Outdoor Wind Environment Simulated Calculation of this Project

The height of the buildings surrounding this project is 40m~110m generally. According to general layout of the project, project model and surrounding building model are accurately built by internationally-usedAirpak hydro-simulation software, and the model is meshed as shown below.

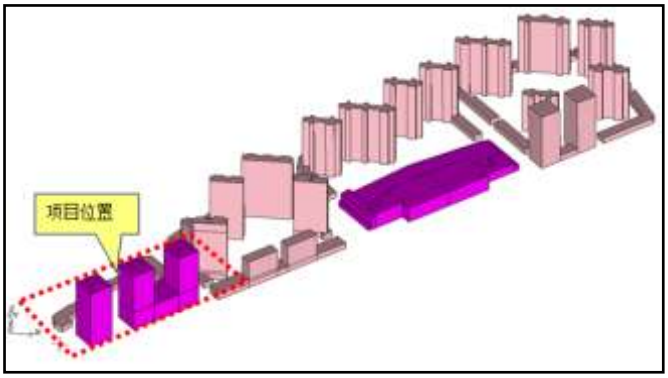

Fig-2: Model drawing of outdoor wind environment

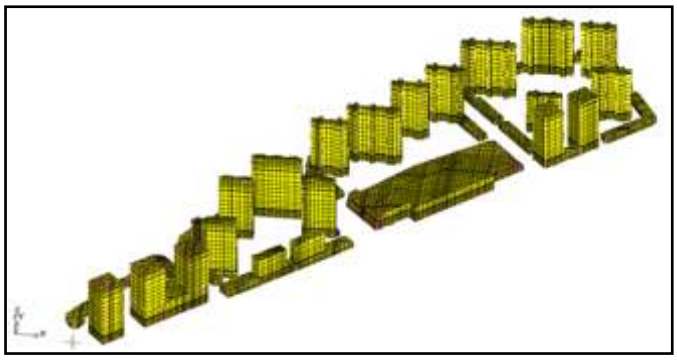

Fig-3: Meshing drawing of outdoor wind environment model

The outdoor wind environment is simulated and analyzed in accordance with the local wind direction and wind speed respectively in summer, transition season and winter, the actual working condition is shown in the table below, simulated results under each condition are illustrated by the following figures.

Table-1:Simulated condition

Working condition	Basic situation	Wind direction	Wind speed(m/s)	Evaluation content
Condition 1	average wind speed in summer, transition season	SW	2.6	Natural ventilation and windproof energy conservation
Condition 2	average wind speed in winter	WSW	3.5	Wind proof energy conservation

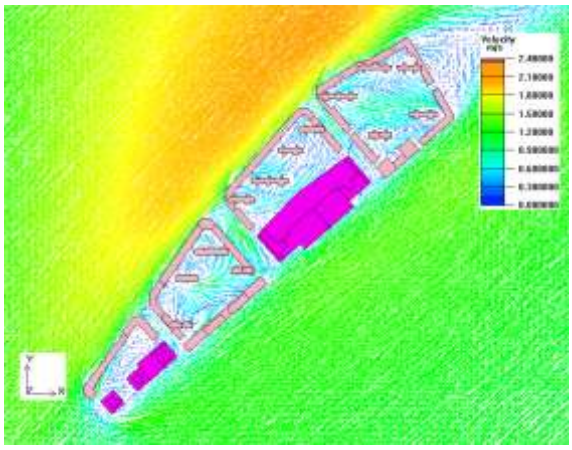

Fig-4: Vectorgraph of wind speed 1.5m above ground(summer, transition season)

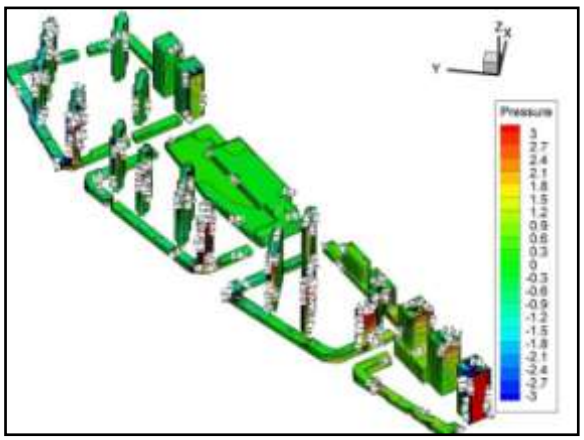

Fig-5: Wind pressure diagram of windward side(summer, transition season)

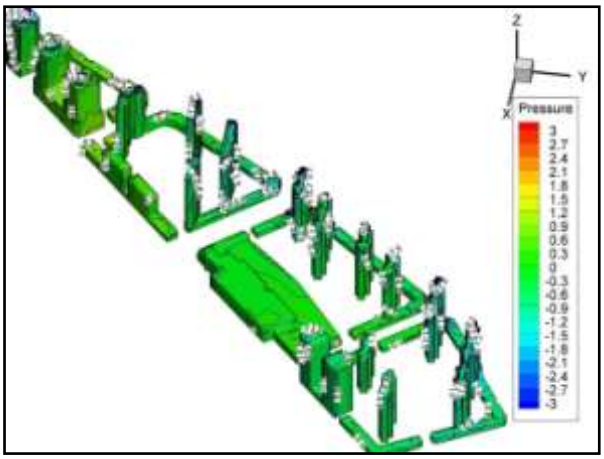

Fig-6: Wind pressure diagram of leeward side (summer, transition season)

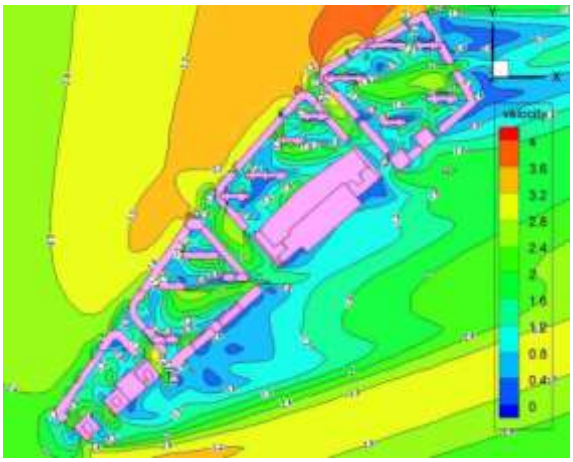

Fig-7: Cloud atlas of wind speed 1.5m above the ground(winter)

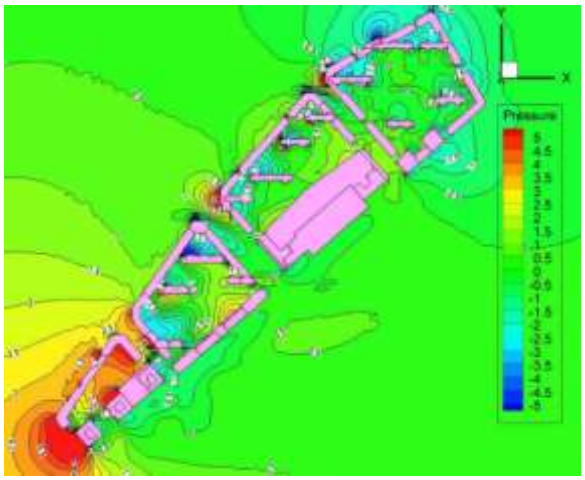

Fig-8: Cloud atlas of wind presssure1.5m above the ground(winter)

The simulated results show that under the working conditions in summer and transition season, flow field surrounding the project area distributes evenly, air flows fluently, there exists no eddy and viscous flow area, wind field streamline of main aisles is generally clear, and there is no obvious dead zone of airflow. The wind pressure difference between indoor and outdoor is generally larger than 0.5Pa.

In winter, maximum wind speed in the region 1.5m above the pedestrian area is about 2.4 m/s, and the wind speed amplification coefficient is less than 2. According to the requirements of item 4.2.6 in [1] GB/T 50378-2014, this item can get the score of 6.

Indoor natural ventilation

Requirements of the items

Item 8.2.10 in [1] GB/T 50378-2014 mainly describes the requirements of outdoor wind environment, the details are as follows:

8.2.10 Optimize building space, plane layout and structure design, improving effect of natural ventilation. Total score for the assessment is 13, the score can be graded according to the following rules:

1. Residential building: grade and add up the score according to the following 2 rules:

i. In hot-summer and warm-winter zone, the ratio of opening ventilation area to the floor area reaches 10%, in hot-summer and cold-winter zone, the ration can reach 8%, and in the other area, the ration can get 5%, score 10 points.

ii. The toilet has window, score 3 points.

2. Public buildings: Under the typical working condition in transition season, ventilation rate in main functional rooms is not less than 2 times per hour, the score can be given according to the scoring rules in table 8.2.10, the highest score is 13 point.

Tab.le-8.2.10: Scoring rules for natural ventilation in functional rooms under typical working condition regarding public buildings

Area proportion R_R	Score
$60\% \le R_R < 65\%$	6
$65\% \le R_R < 70\%$	7
$70\% \le R_R < 75\%$	8
$75\% \le R_R < 80\%$	9
$80\% \le R_R < 85\%$	10
$85\% \le R_R < 90\%$	11
$90\% \le R_R < 95\%$	12
$R_R \ge 95\%$	13

Simulated calculation of natural ventilation in this project

During the design phase of this project, the position of indoor ventilation opening is optimized, the surrounding openings are evenly distributed, and it is conducive to the form cross ventilation and better air distribution. According to general layout of the project, build and mesh the model of the typical floors(floor18~20, totally 3 floors) by internationally-used Airpak hydro-simulation software, take the outdoor wind simulation results under summer and transition working conditions as boundary condition, and conduct the indoor natural ventilation simulation analysis. The model of selected floors and meshing effect is shown respectively in figure 5~8.

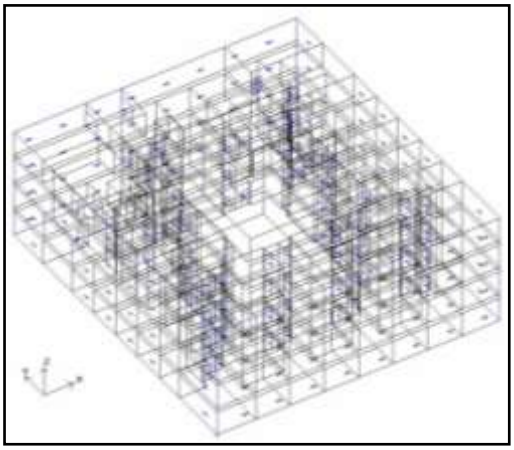

Fig-9: Indoor natural ventilation model of floor 18~20

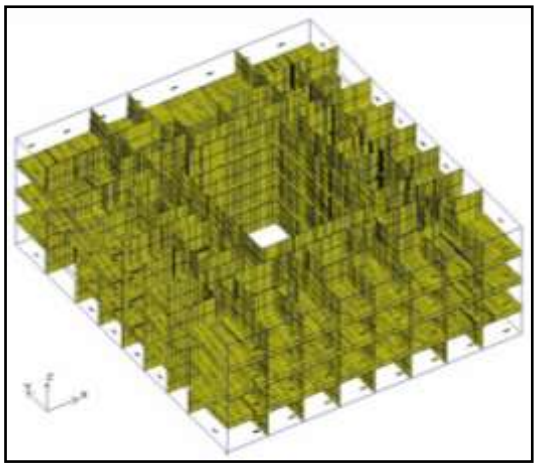

Fig-10: Indoor natural ventilation model meshing effect drawing of floor 18~20

According to the outdoor wind environment simulation results in this plant, take the simulation results under prevailing wind direction SW and average wind speed in summer and transition season as boundary condition. Because building elevation pressure difference is relatively small, ventilation effect is not so good, so take the changing of wind pressure at different times into consideration, set the building wind pressure difference at 3Pa to promote the ventilation requirements. Take the 18th floor as example, the simulation result is shown in the following figure.

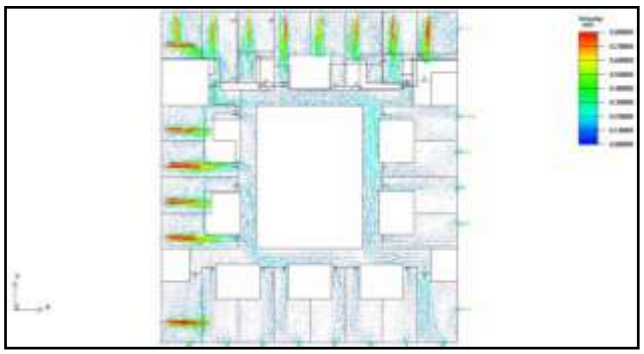

Fig-11: Distribution of flow field from 1.2m above the 18th floor

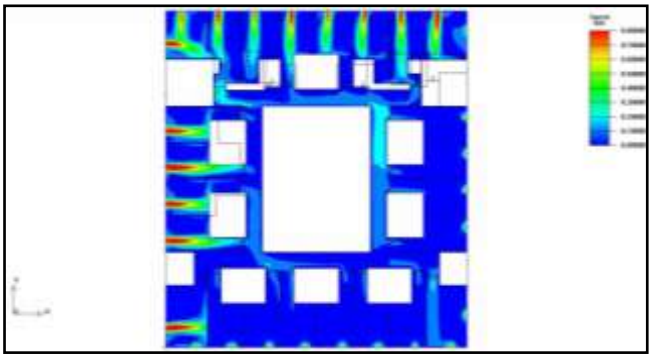

Fig-12: Wind speed distribution from 1.2m above the 18th floor

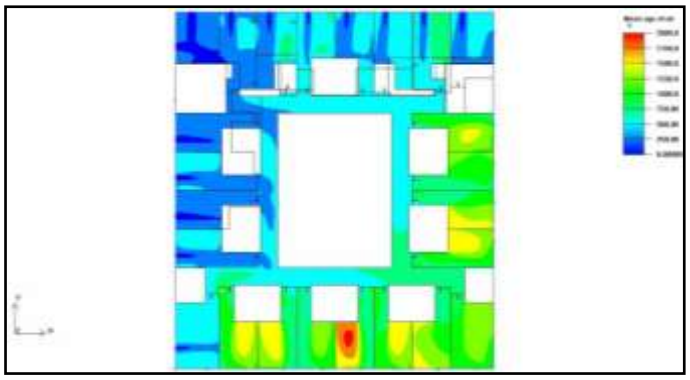

Fig-13: Air age distribution from 1.2m above the 18th floor

As shown in figure11~13: for the 18th floor, the air flow mainly goes inside from the northern and western air inlets 18, and goes outside the building from the others openings, the ventilation openings are distributed evenly, and this is good for the indoor natural ventilation. The wind speed at the northern and western openings is relatively high, approximately in the range of 0.4~0.8 m/s, in some partial position, the speed can be higher than 0.8 m/s, however, for the left most region of the building, the wind speed is normally under 0.2 m/s. For the whole indoor area, the wind speed is lower than 1.4 m/s, this can meet the requirements for comfortable indoor wind speed without air conditioning. In the zone of hotel rooms in east and south of the 18th floor, air age is relatively big, approximately in the range of 1000~2000s. And for the west and north part, the air age ranges from 250~750 s, the overall ventilation effect is relatively good, and the air quality can be guaranteed well.

According to the statistics, in this plant, under the condition that in summer, transition season and winter, prevailing wind direction SW, average wind speed 2.6 m/s, and in case all the operable windows are open, total ventilation quantity for the main functional space on the 18th floor is 2.85 m^3/s, volume of the ventilated area is about 3157 m^3, ventilation rate is about 3.25 times per hour, more frequent than 2 times per hour, it can meet the requirements of item 8.2.10 in [1] GB/T 50378-2014, and can get the score of 13 points.

CONCLUSION

[1] GB/T 50378-2014set forth higher requirements for building design. As a kind of passive technology, passive ventilation has been applied more and more extensively in green building industry. For the wind environment simulation analysis of green building, the influence of outdoor wind field and wind environment on indoor environment is taken into consideration. In this paper, the simulation and optimizing about outdoor wind environment and indoor natural ventilation of one hotel in Inner Mongolia are made, and the relevant items in [1] GB/T 50378-2014 are graded according to the simulation results. The results shows that in this project, outdoor wind environment (item 4.2.6) can get the score of 6, indoor natural ventilation (item 8.2.10) can get a score of 13. The method adopted in this project also provided some reference for the simulation of outdoorand indoor wind environment in green buildings.

REFERENCE

1. Assessment standard for green building》GB/T 50378-2014[S]. Beijing: China Architecture & Building Press, 2014.
2. Technical manual for green building evaluation [M]. Beijing: China Architecture & Building Press, 2010.