Cooling Load Forecasting For Typical Office Buildings

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Abstract. The heating and cooling load prediction model of an office building is established by using DesignBuilder V5 software. Some boundary conditions are obtained through investigation, and the annual heating and cooling load of the building is calculated by simulation. The maximum value of the cooling load is compared with the actual operation, and the maximum relative error results are within 10%. The model can provide reference for the load prediction of other office buildings.

1. Introduction

The reasonable prediction of dynamic load of office building can provide a powerful reference for the design of air-conditioning heat storage device, the selection of cold source system and equipment collocation, and urban energy planning. Some scholars have made many researches on load forecasting, Lin et al.[1] used a new method combining software simulation and scenario analysis to forecast a CBD's building air -conditioning loads then predicted the air-conditioning loads of the energy center. Chen et al. [2] established a rapid prediction model for cooling and heating load of typical buildings, and the accuracy of the mathematical model was verified. Zhang el al. [3] taking a typical office building in Beijing as an example, the hourly load coefficient suitable for China's office building is obtained by combining simulation with empirical value.

An office park is powered by two 315kW gas internal combustion engine generators and two lithium bromide units, supplying hot and cold load for two office buildings.

Figure 1. Power Station

Taking the two office buildings in the park as the research object, the commercial energy consumption analysis software DesignBuilder V5 was used to simulate the annual cooling and heating load, the accuracy of the model was verified by comparing with the running data.

DesignBuilder V5 was developed by the company of the United Kingdom. It is a comprehensive user graphical interface simulation software developed for EnergyPlus, which can be used for building heating/cooling, refrigeration, lighting, ventilation, lighting, etc.. Total energy consumption simulation analysis and economic analysis. It is energy-saving architectural design software that realizes the environment from the planning stage. [4]

2. Model

2.1. Geometric model
Since the geometry of the two buildings is exactly the same, only one of the buildings is studied. The auxiliary buildings and PV panels (Photovoltaic panels) are mapped to simulate the effect of occlusion on building energy consumption. The model was shown in figure 2 below.
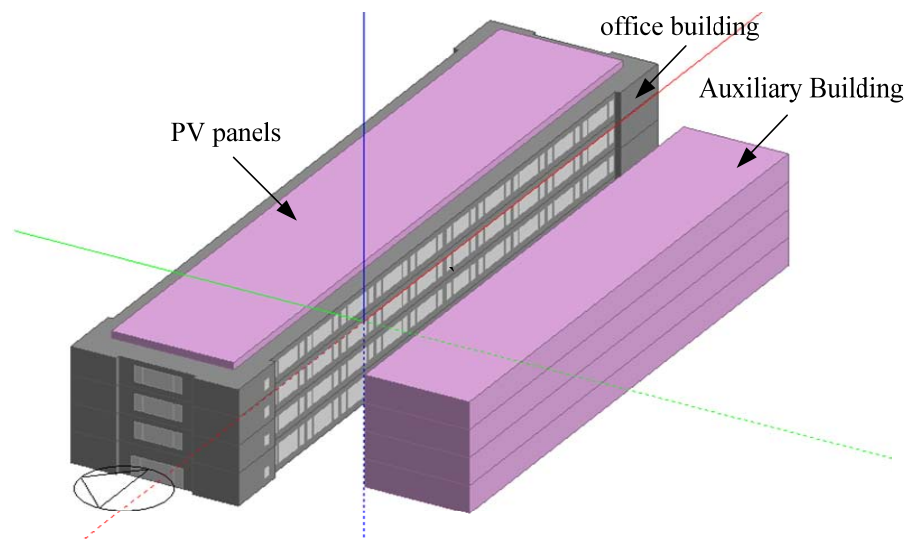

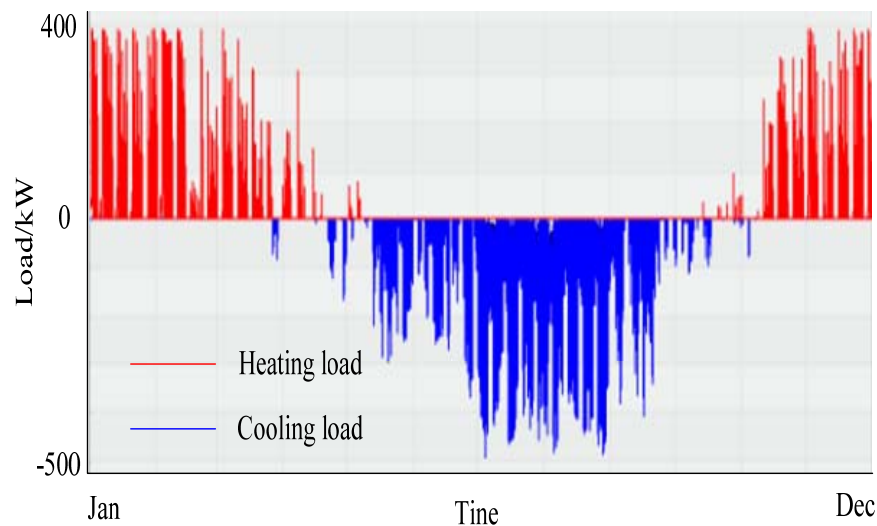**Figure 2.** Diagram of the model

2.2. Boundary conditions
The parameters of personnel density, equipment density, lighting density and energy using time are obtained by field investigation, which are listed in table 1. Meteorological conditions are provided by software systems, due to the lack of relevant materials, the enclosure structure adopts the system default setting. The information of office buildings were shown in table 2, the results of simulation was shown in figure 3.
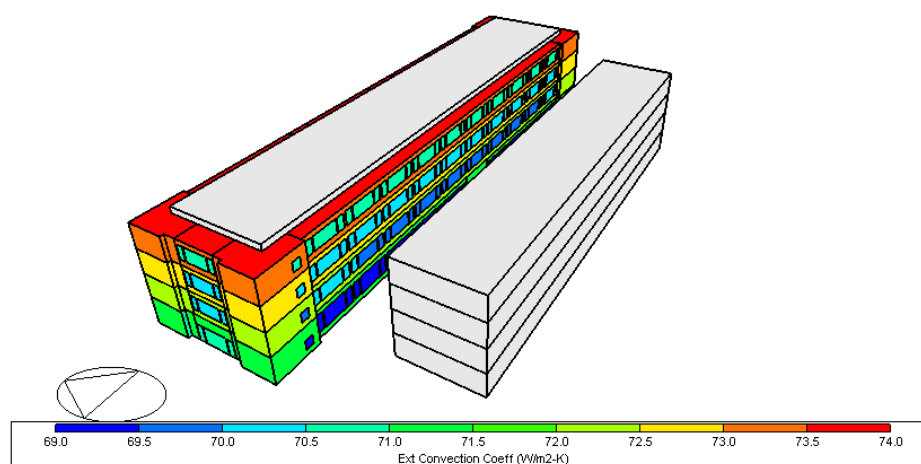
Table 1. Boundary Conditions

Serial Number	Name	Values(W/m^2)
1	personnel density	0.05 (person/m^2)
2	equipment density	15W/m^2
3	lighting density	9W/m^2
4	Schedule	From 8:00 to 17:00 From Mon to Fri
5	Design temperature (Summer)	26℃
6	Design temperature (Winter)	18℃

Table 2. Boundary Conditions

Name	Office building 1	Office building 2
floor space	7374m^2	7374m^2
Air conditioning area	5530m^2	4000m^2

Figure 3. Heating and Cooling Load

As can be seen from Figure 3, the maximum cooling load of building 1 is about 500 kW. According to the ratio of energy supply area, the maximum cooling load of building 2 is estimated to be about 360 kW, so the maximum cooling load is about 860kW in the park by simulation.

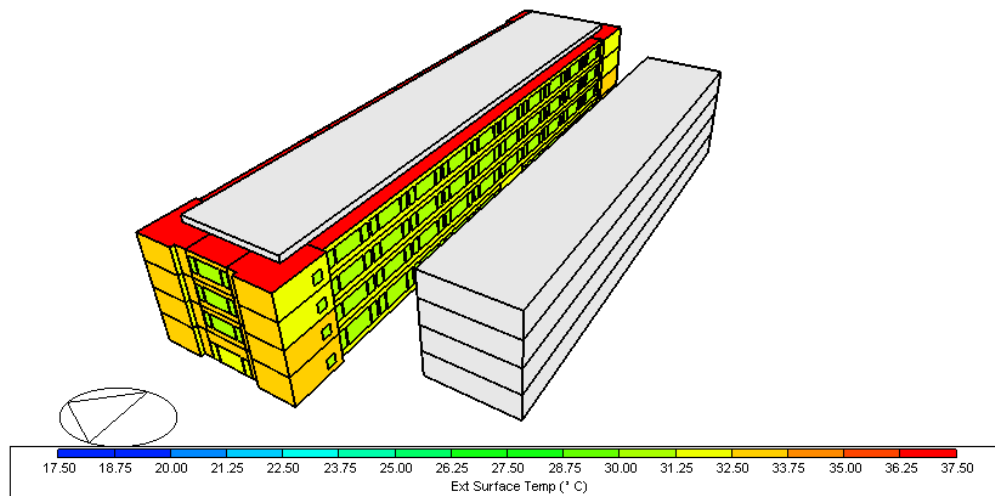**Figure 4.** Heat transfer coefficient of external walls
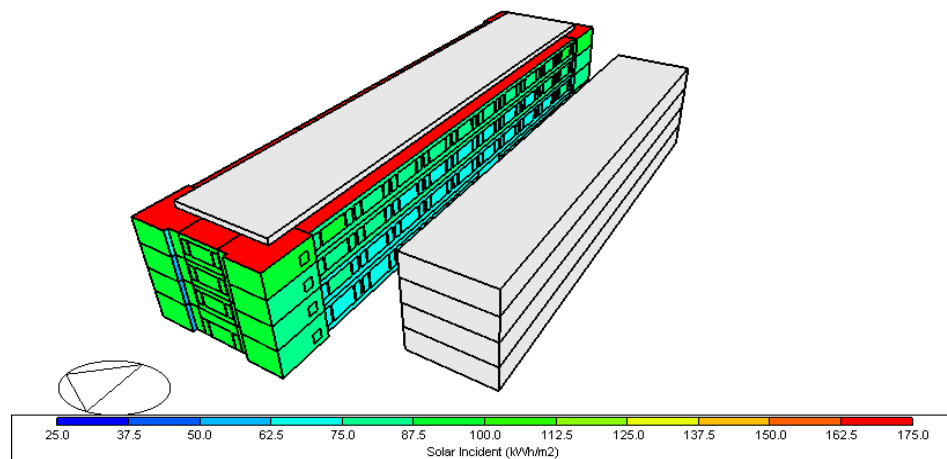
Figure 5. Temperature of external walls

Figure 6. Solar radiation intensity on external walls

Figure3-6 shown that, the higher of the floor, the greater value of solar incident, temperature and heat transfer coefficient of external walls, because upper floor get more solar radiation.

To verify the accuracy of the model, recording of hourly energy supply data for lithium bromide units when the maximum temperature exceeds 37℃ the maximum cold load is approximately 790kW, which occurs between 15:00 p.m. and 16:00 p.m.

3. Conclusion

The maximum cooling load is 860kW by simulation, and the actual value is 790kW. The simulated value is 70kW more than the actual value, and the relative error is about 8.9 % (less than 10%). Therefore, the simulation results have certain reference value. According to the actual operation situation, the cooling load index of the office building in the park is about 83W/m^2. There are three reasons for the error of the simulation results:

(1). Firstly, due to the lack of specific parameters of the maintenance structure in the simulation calculation, the default values are different from the actual situation;

(2). Secondly, the actual air conditioning area is actually dynamic and has a certain degree of uncertainty. Therefore, the simulation calculation will also produce certain errors;

(3). The last, there are some errors between the shading mode and the actual situation used in the model.

References

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[2]   Chen Feiyang. Xu Jianqun, Wang Feiyang, et al. Research on Building Cooling and Heating Load Prediction Model on User's Side in Energy Internet System, 2015,pp.3678-3684.

[3]   Zhang Jie, Li Deying.Load forecasting for typical office buildings ,Building Energy Efficiency,2012,pp.58-60.

[4]   Information on https://www.designbuilder.co.uk/.