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Study on Natural Ventilation for Civil Buildings

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Abstract

The improvement of living environment in homes and workplaces is also essential. Nowadays, many countries around the world have implemented many house models that apply natural ventilation to the house instead of artificial air conditioning system, because natural wind is better and also feels more comfortable. Therefore, the study of controlled natural ventilation architecture is necessary. In this paper, the author uses Ansys software, based on the finite volume method, to simulate the natural ventilation process for the office building of Viet Cuong company, Tan An city, Long An province.

Key word: *natural ventilation, Finite Volume Method,* Ansys

1 Introduction

Natural ventilation provides greater thermal and humidity comfort than mechanical ventilation systems. So now many places have researched smart home solutions to improve the quality of life. In which the design of controlled and automatic natural ventilation systems has a big role.

Controlling natural ventilation does not require any instruction, and the operation is completely clear and familiar to everyone, so it is not the subject of this study. However, the operation is not the subject of this study. Automated natural ventilation requires a combination of technologies from many fields.

Currently, there are no general principles to guide the design of automatic natural ventilation control systems in buildings. Meanwhile, the rapid development of smart homes with the requirement to automatically control technical systems, including the organization of natural ventilation, makes the study of control strategies difficult. Automatic ventilation becomes more and more necessary.

2 Theoretical basis

2.1 Finite volumne method [2]

The finite volume method is a numerical method based on the integration of fundamental equations when considering the simplest case of fluid transmission processes: pure diffusion in the flow. steady flow). Rewrite the Navier-Stokes equation for the one dimensional case

$$\rho\left(\frac{\partial v_x}{\partial t}+v_x\frac{\partial v_x}{\partial t}+\partial v_y\frac{\partial v_y}{\partial y}+\partial v_z\frac{\partial v_z}{\partial z}\right)=\rho g_x-\frac{\partial p}{\partial x}+\mu\left(\frac{\partial^2 v_x}{\partial x^2}+\frac{\partial^2 v_x}{\partial y^2}+\frac{\partial^2 v_x}{\partial z^2}\right)$$

$$\Rightarrow \rho\frac{\partial \phi}{\partial t}+\rho\mathrm{div}(\phi\mathbf{u})=\rho g_x-\frac{\partial p}{\partial x}+\mu\mathrm{div}(\mathrm{grad}\phi)$$

To solve the problem of finite volume for the case of stable diffusion usually follow the sequence of steps: create a mesh (Mesh generation): divide the model into discrete parts, the nodes are between the two ends of the model, the boundary of the nodes is between two adjacent nodes. each node is surrounded by one element or one control volume

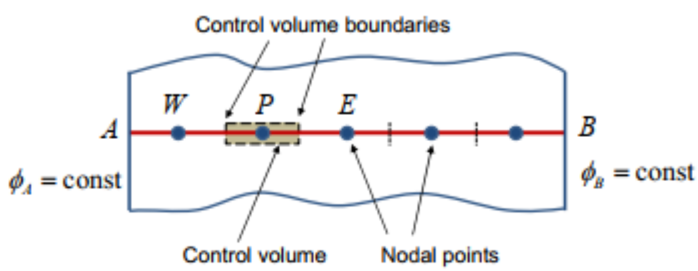

Figure 1. Control volume

Discrestisation

$$\int_{\Delta V}\frac{d}{dx}\left(\Gamma\frac{d\phi}{dx}\right)dV+\int_{\Delta V}SdV=\left(\Gamma\frac{d\phi}{dx}\right)_e-\left(\Gamma A\frac{d\phi}{dx}\right)_w+\bar{S}\Delta V=0$$

A : cross-sectional area of the control volume.

ΔV : control volume.

$\bar{S}$: average value of power supply for control volume.

2.2 Characteristics of turbulent currents [2]

Turbulent and non-periodic motion, in which transmission quantities such as velocity, mass temperature, etc. vary over time and space. The characteristic component of turbulence is turbulence eddies.

The properties of flow and velocity are shown as random values, results can only be obtained by enumerating the values and averaging.

The size of turbulence eddies has a wide range. Large vortices get energy from the flow, energy is transferred from large vortices into small vortices. When the vortices are small enough, the turbulent energy is converted into the internal energy of the stream due to viscous dissipation.

3 Numerical result and discussions

Select the simulation architecture is the office building of Viet Cuong Canning Company Limited, Tan An City, Long An Province. Long An is located in the humid tropical monsoon climate zone. The calmest month of the year in Tan An is October, with an average wind speed of 9.9 km/h.

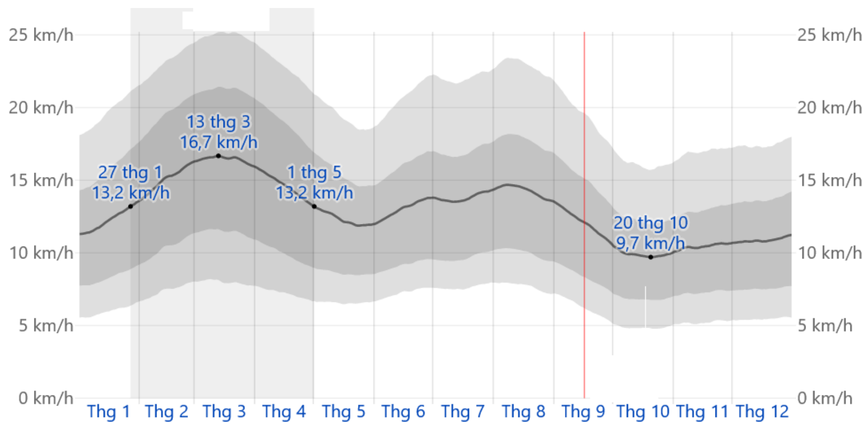

Figure 2. Wind speed chart in the year

This paper will simulate ventilation and improve natural ventilation for the second floor of the architecture. From there, review the results of the air velocity and temperature fields and compare them with the thermal comfort standards, on the wind. Export the results as a graph at approximately one meter and sixty centimeters. If not satisfied, give the improvement method and comment. The puppet model used will be the model $k-\varepsilon$ with the following advantages: Ensuring a balance between computational costs and high accuracy. The model is simple, requires little input data to calculate, only needs initial or boundary conditions. Can be used for a wide range of industrial flows. Well established and widely tested for reliability.

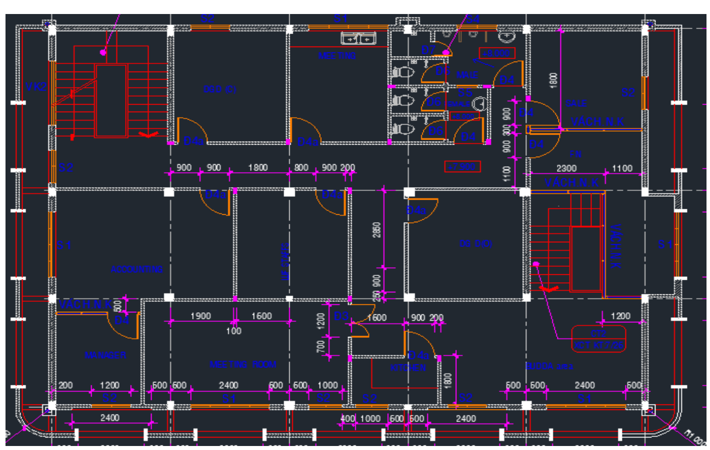

Figure 3. Second floor design drawing

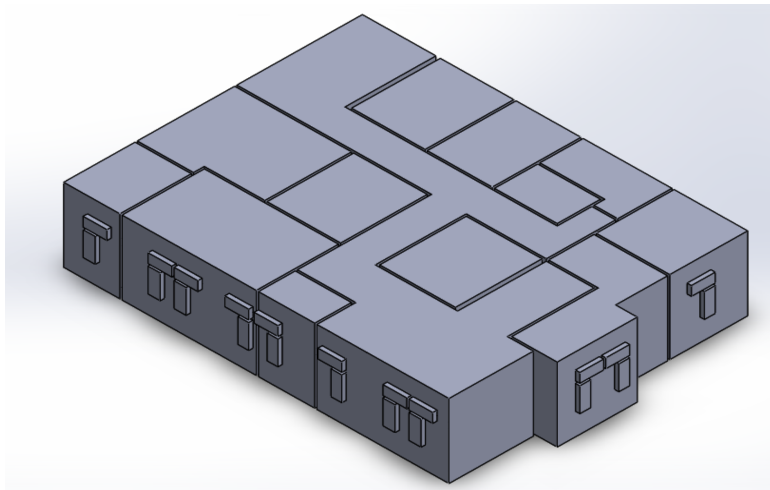

Figure 4. Fluid model based on drawings

Selected inlet wind speed is 2.75 m/s (9.9 km/h). The temperature of the eastern edges will choose about 400^0C. Relative pressure is 0 Pa. The remain are solid walls.

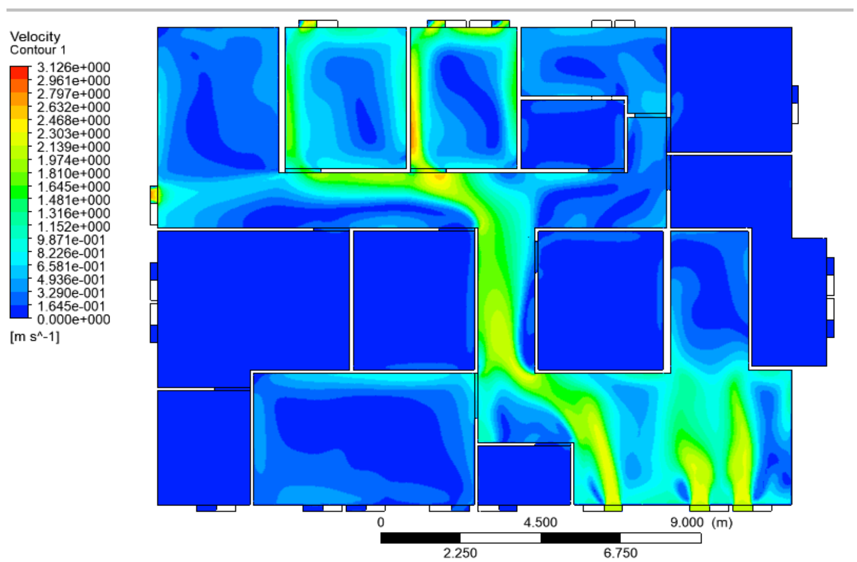

Figure 5. Wind velocity field at an altitude of one meter and sixty centimeters

According to the simulation results, it can be seen that most spaces such as corridors, stairs, and rest areas outside the working rooms all have high air circulation when there is wind in. This ensures the air quality inside the building as there is always fresh outside air to continuously replace the inside air and the wind speed also meets the allowable level for the air speed comfort standard. air in architecture.

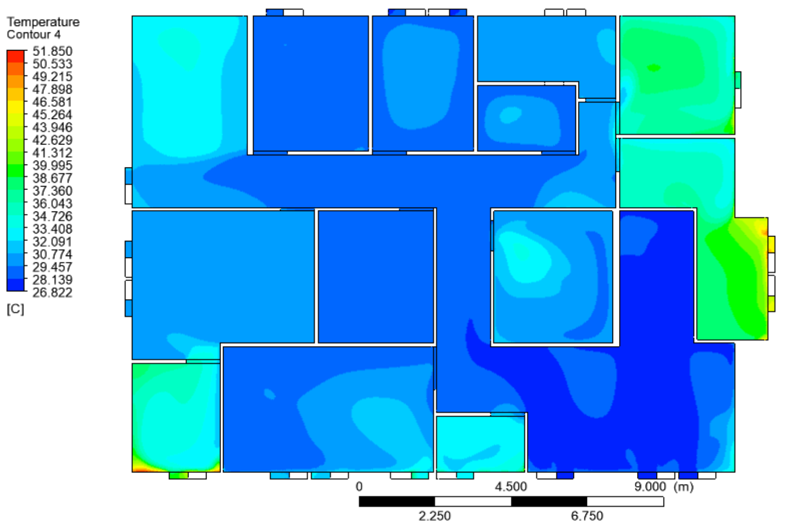

Figure 6. Temperature field at altitude one meter and sixty centimeters.

Most areas in the architecture have a comfortable temperature for rest and light work, except for some working rooms with surfaces exposed to direct sunlight and no wind blowing. We must use forced ventilation measures such as air conditioners, etc. But the room does not have wind in but still meets the thermal standards because there are no surfaces directly exposed to sunlight. so there is no convection phenomenon that increases the room temperature. Although the architecture has met quite well the requirements for room temperature and air speed inside, it can still be improved. Add a single window on the left side and a double window on the right side of the structure to improve ventilation when the wind blows from the west side of the structure.

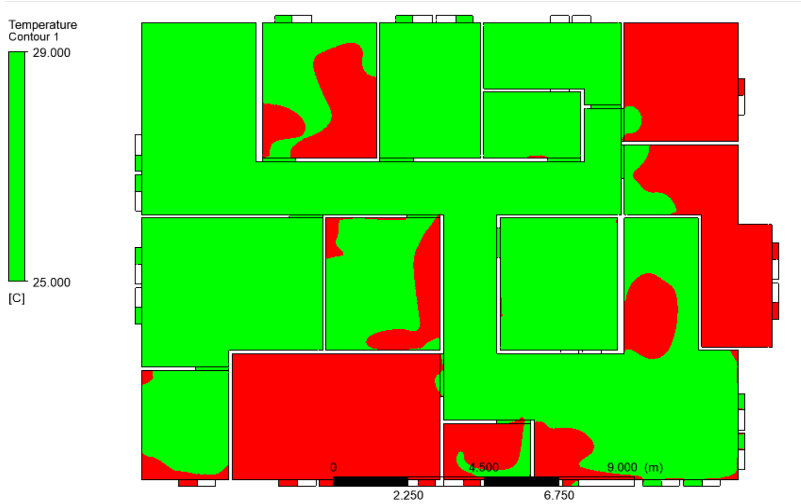

Figure 7. Temperature field after adding window

With the same temperature level, after adding the corrections, the right space area has improved in terms of temperature. In addition, the air speed when there is wind is also improved.

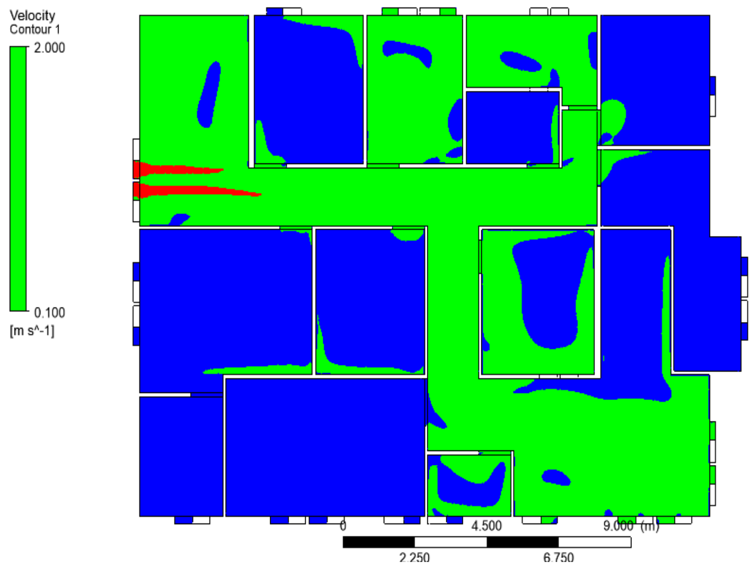

Figure 8. Velocity field after adding window

Adding a left window will significantly increase the air flow, but will not affect the old design (stairs). Adding a double window on the right helps the wind flow to more areas than the old design, and can also take advantage of the window to get fresh wind and catch the northeast wind in May-October. The old design can only catch the southwest wind but not the northeast wind because the windows in the original design are only open to the office and cannot create circulation inside other areas of the floor. .Same heat level, after adding the windows, the right space has improved in terms of temperature. In addition, the air speed when there is wind is also improved.

4 Conclusion

According to the simulation results, we see that the architecture responds well to natural ventilation for houses, the standards of heat and wind speed are also within the allowable levels of the microclimate. However, there are still rooms that cannot use natural ventilation, so it is necessary to have forced ventilation measures instead, to meet the thermal comfort needs of the people inside. The design of the position of the doors and the height of the windows and vents all create good conditions for natural ventilation. The simulation software can also meet the needs of ventilation simulation to save costs.

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