CHAPTER 5

CONCLUSION AND SUGGESTION

The last chapter of this thesis is to deliver the main conclusions of the current work and recommendations for future researches. The first section of this chapter provides main conclusion which answer the requirement of objectives. Then, for suggestion, proposing related to Trombe wall ratio and other technique will be taken into account.

5.1 Conclusion

Previous works have documented the effectiveness of Trombe wall by experimenting on Trombe wall best ratio, thus illustrated the benefit of applying the system to improve indoor ventilation and saving energy load in buildings. However, it is still needed to see the performance of Trombe wall by applying the recommended ratio to the available size of top stair block wall of Phnom Penh row house. This thesis aims to contribute this system to certainly see the real amount of air it can make. And later, take an investigation on indoor ventilation rate between the typical design of row house and the new design with trombe wall on ground floor facilities of the house where contains living room and kitchen. Most of prior studies conducted the experiments by using real experiments compare with mathematics theories. However, using computation fluid dynamic (CFD) program as simulation tool for this current work gives several benefits. Meanwhile many scholar articles proofed about the reliability of CFD simulation compared with mathematics theories and real experiments, this program is the only good way to compare many testing cases with the ability to apply the same boundary conditions in demand.

This study obtains 10 experiment cases which divided into two categories. First group took noticed about modeling of top stair block chamber. It contained 5 cases varies by heat flux from 200W/m^2 to 1000W/m^2. The result of average velocity at steady were 0.14m/s, 0.19m/s, 0.22m/s, 0.26m/s, 0.28m/s for the heat flux 200W/m^2, 400W/m^2, 600W/m^2, 800W/m^2, and 1000W/m^2 respectively. The highest velocity in channel happened near the glass surface in value of 0.89m/s at steady state of 200 seconds. The lowest heat flux created its maximum wind speed of 0.39m/s. Temperature in channel was dropped by the presence of cool air from inlet passed through the channel. From heat flux 200W/m^2 to 1000W/m^2 temperature deceased from 12K to 33K compared with temperature on glass at first set up, and 4K to 22K compared with the temperature on wall beforehand. On the other hand, highest mass flow rate gotten at inlet of the system was approximately varies from 0.06Kg/s to 0.115Kg/s from heat flux 200W/m^2 to 1000W/m^2. This is such appreciable amount like other experiments from prior researchers.

Another group was about whole house simulation which comprised another 5 cases studies include the case of NTW, HC-NTW, TW1000W/m^2, HC-TW1000W/m^2, and 200W/m^2. Even Trombe wall system are recommended for tropical region to enhance indoor ventilation, it should be considered that side of the system, distance from Trombe wall to target room, the volume of target room, and ambient weather are relevant to the achieved result. Unlike inlet position of the Trombe wall design, and limit size of the system which could produce small capability to drag the air into the channel compare to the big volume of ground floor, the existing outlets of the typical house could provide a better favor to push the air to the exit with higher ventilation rate. Furthermore, the problem caused from too small size of the system compared to the achieved target rooms' volume which made resistance of flow passing through the Trombe wall channel to outlet. In this case, the existing outlet without Trombe wall design could performed to evacuate the air smoother than the applying of Trombe wall. However, this result was acceptable in case of the cement grill of existing outlet had been removed out like the modeling set up only. For all cases, the approximately air velocity gotten at living room is in average from 0.12m/s to 0.16m/s. At the same time, hot air was brought in by the blowing in wind, result in the increasing of room temperature $3^{o}C$ to $4^{o}C$ in living room. Anyway, there were mostly same result of air velocity and temperature in kitchen for each case due to the location as dead end of this room. Within these range of temperature and air velocity, this technique cannot satisfy the need of comfort standard.

In conclusion, it could be assumed that Trombe wall system could produced a good result of velocity which could reach the comfort velocity needed as stated by other researchers. The relationship between temperature, velocity, and air mass flow rate acceptance from the channel was logically response to the theory. However, the installation of Trombe wall on the top of stair block wouldn't influence air flow from ground floor area of row house. The result also indicated that the flow was automatically moved by the boundary condition of pressure different, and not by the effect heat flux value at the system. However, the assistance of blowing-in wind may help to increase system performance and approach the extension zone of comfort if wind speed increase at least up to 0.69m/s.

5.2 Limitation

CFD program contributed as significant tool in comparison between the existing designs with the proposed Trombe wall usage. For this method could equally generate the simulation in any cases with the same input conditions while it is hard to make in real model testing, so that cause and effect of each argument could be analyzed with reliability reason. However, base on the method of this study, finding high spec of computers is the main major problem for running XFlow CFD program. The recommended spec is Core i7 processor, 12-24GB on memory, more than 1TB hard drive space, and at least 1GB of graphic card. In contrary, the available spec of computers to handle this simulation was just a Core i3 processor with 4GB memory. This matters the duration of simulation process. For the group of stair block chamber simulation, to reach the steady state, it took more than 7 days to complete 200 seconds of a case study. Anyway, with the available provided computer, it was so hard to handle the simulation of whole house until the steady state. In addition, it was the main reason of picking up 60 seconds time only on simulation to visualize flow movement in the house. The simulation took 6-7 days to finish that 60 seconds experiment for one case.

5.3 Recommendation for future research

As mentioned about the result and matter of this thesis, next researchers should consider later on the following topics:

- The ratio of suitable Trombe wall size compare with target room volume.
- Next researcher should also try to run simulation of whole house until steady state to better see a clearer analysis on flow.
- Further investigation on Solar induce ventilation technique to improve ventilation in row house condition, by designing a bigger in demanding size whether on stair chamber or other suggestion place.
- Finding other passive techniques beside Trombe wall and Wind Catcher which could be expected to provide better result for row house occupants living comfort.