UNIVERSITI TEKNOLOGI MARA

ANALYSIS ON THE EFFECT OF THE UPPER WALL OPENING ON THE NATURAL VENTILATION PERFORMANCE IN BUILDING

AZIZ FAIZ BIN SHAHIR

Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science
(Mechanical Engineering)

Faculty of Mechanical Engineering

November 2018

ABSTRACT

Wind-driven natural ventilation has been known as an effective passive design alternative to active ventilation system towards development of sustainable buildings. This free source of energy needs to be fully utilized by peoples where it can be accommodated to minimize energy consumption in which cost comes from the process of cooling using electrical device such as air conditioning unit and exhaust fans. This study aims to investigate the effects of various locations of upper wall opening i.e. that connects lower floor and upper floor in two-storey building on the ventilation flowrate. Furthermore, its crucial to evaluate the air velocity profile and flow distribution in the two-storey building under different facades and upper wall opening location. There were six building models involved which consist of asymmetric openings on the building facades with different locations of upper wall opening. Steady 3-dimensional Reynolds-averaged Navier-Stokes (RANS) equations with the realizable k-ϵ turbulence model are solved by means of computational fluid dynamics (CFD) simulation. The computational grid is based on a grid sensitivity analysis and the preliminary simulation results are validated based on available literature which provides data measurement on wind tunnel experiment using Particle Image Velocimetry (PIV) method. The results revealed that for different façade opening configuration, building with double inlet and double outlet recorded the highest percentage of ventilation flow rate which was about 97.6 % compared to the reference building models. The least was recorded by building with single inlet and single outlet which was only 25 % which decrease 72.6 %. However, for different variation of upper wall opening position, the biggest percentage different of volume flowrate was building with double inlet and single outlet with 6.7 % and the lowest was building with single inlet and double outlet with 1.9 %. Therefore, building with double inlet and double outlet is consider as the best building model available compare to others. For overall evaluation, upper wall opening for position 6 was chosen as the favorable location due to high ventilation flowrate recorded based on building model with three facades open. It clearly shows that the significant impact of upper wall opening as airflow path between two floor level is slightly modify the airflow penetration for indoor ventilation on two-storey building types. Finally, with appropriate combination between façade opening configuration and upper wall opening positions, it significantly modified the airflow structure at the lower and upper floor section and at once it produces better wind-induced ventilation across the building area.

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to the Ministry of Higher Education Malaysia and Faculty of Mechanical of Engineering, Universiti Teknologi MARA (UiTM) for providing the scholarship, support and opportunity for my master study. I also extend my appreciation to my main supervisor Dr Mohd Faizal Bin Mohamad and co-supervisor Dr. Azli Bin Abd Razak for continued support, suggestions and guidance during my study's journey. Also, I am thankful to Dr Naoki Ikegaya from Kyushu University (Japan) for his valuable comments and suggestion for improvement on my data analysis. Special thanks to Dr. Sharul Azam, Head of Computer Aided Design, Engineering and Manufacturing Department (CADEM), Faculty of Mechanical Engineering (UiTM) for the workstations facility.

I want to express a big thank to all respectful people who had constantly helped and shared their knowledge and expertise through the process of completing this study. Also, a million of thanks to my colleagues from Faculty of Mechanical Engineering especially those from Wind Engineering Research Group (WERG), who had always given motivation and positive moral support to me to complete this thesis writing.

Last but not least, I would like to extend my sincerest love, thanks and appreciation to all my family members and for their continuous support and encouragement because this has become my motivation and inspiration. Without them, I would not be able to achieve all that I have achieved and for that I will always be grateful.

TABLE OF CONTENT