ASSESSMENT OF THE POTENTIAL NATURAL VENTILATION ON TYPICAL HOUSE IN MALAYSIA

OOI WEI JIE

BACHELOR OF CIVIL ENGINEERING
UNIVERSITI MALAYSIA PAHANG

ASSESSMENT OF THE POTENTIAL NATURAL VENTILATION ON TYPICAL HOUSE IN MALAYSIA

OOI WEI JIE

Report submitted in partial fulfilment of the requirements
for the award of the degree of

Bachelor of Civil Engineering with Hons
Faculty of Civil Engineering and Earth Resources
UNIVERSITI MALAYSIA PAHANG

JUNE 2015

DECLARATION OF THESIS AND COPYRIGHT

Author's full name	:	OOI WEI JIE
Date of birth	:	05 APRIL 1991
Title	:	ASSESSMENT OF THE POTENTIAL NATURAL VENTILATION ON TYPICAL HOUSE IN MALAYSIA
Academic Session	:	2014/2015

I declare that this thesis is classified as :

☐	**CONFIDENTIAL**	(Contains confidential information under the Official Secret Act 1972)*
☐	**RESTRICTED**	(Contains restricted information as specified by the organization where research was done)*
☑	**OPEN ACCESS**	I agree that my thesis to be published as online open access (Full text)

I acknowledge that Universiti Malaysia Pahang reserve the right as follows:

1. The Thesis is the Property of University Malaysia Pahang
2. The Library of University Malaysia Pahang has the right to make copies for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified By:

(Student's Signature)	(Signature of Supervisor)
910405-08-5923	MR. NORAM I.RAMLI
New IC / Passport Number	Name of Supervisor
Date : 29 JUNE 2015	Date : 29 JUNE 2015

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Civil Engineering.

Signature : …………………………..
Name of Supervisor : MR NORAM I.RAMLI
Date : 29th JUNE 2015

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature :

Name : OOI WEI JIE

ID Number : AA11124

Date :29th JUNE 2015

ACKNOWLEDGEMENTS

With the help and support of numerous people, this dissertation has been successfully completed. First of all, my millions credit goes to my thesis supervisor, Mr. Noram I. Ramli for all his brilliant guidance and warmest encouragement throughout the process. Mr. Noram has broadened my view in this field and enriched my knowledge throughout the times we worked together.

Secondly, my sincere thanks go to all of my friends for their kindness which offertheir help for my research works and always being there for me when there are needed in my bachelor studies. Also, a special gratitude to all the lecturers of Faculty of Civil Engineering and Earth Resources for their excellent guidance and advices either in direct method or indirect method.

Last but not least, I would like to express my deepest appreciations to the one I loved and my family, the one whom I love the most and support me from the beginning until the end of my bachelor degree life. Thanks them for all the endless support and caring throughout the years and keep me in strength when I am helpless and guide me towards the future.

ABSTRACT

Natural ventilation is nowadays become significantly applied in buildings to maintain a healthy and comfortable indoor climate. The driving force for natural ventilation can be introduce by allowing the wind speed pass through flow to the building. Recently in Malaysia, issues of comfortable indoor climate are expressively discuss. Therefore this study was conducted to investigate the potential of natural ventilation in Malaysian housing system. Two typical housing design were used in this study where one with jack roof system and another without. Computational Fluid Dynamic were used in this study in order to examine the potential of natural ventilation between this two typical roof systems. From the result it was clearly shown that the house with jack roof system are shows more effective compare to the roof without opening. Result also shown that the arrangement of the opening may also affected of the performance of natural ventilation. Therefore it can be conclude the proper design in roof system may introduce the ventilation of the house.

ABSTRAK

Pengudaraan semula jadi yang kini menjadi kian ketara digunakan dalam bangunan untuk mengekalkan iklim dalaman yang sihat dan selesa. Kuasa penggerak untuk pengudaraan semula jadi boleh diperkenalkan dengan membenarkan kelajuan angin melalui aliran ke dalam bangunan tersebut. Baru-baru ini di Malaysia, isu-isu iklim tertutup selesa yang penuh perasaan, berbincang. Oleh itu kajian ini dijalankan untuk mengkaji potensi pengudaraan semula jadi dalam sistem perumahan Malaysia. Dua biasa reka bentuk perumahan telah digunakan dalam kajian ini di mana seseorang dengan sistem jack bumbung dan satu lagi tanpa. Komputasi Dinamik Bendalir telah digunakan dalam kajian ini untuk mengkaji potensi pengudaraan semula jadi antara dua sistem ini bumbung biasa. Dari keputusan itu jelas menunjukkan bahawa rumah dengan sistem bumbung jack adalah persembahan yang lebih berkesan berbanding dengan bumbung tanpa pembukaan. Keputusan juga menunjukkan bahawa susunan pembukaan juga boleh terjejas prestasi pengudaraan semula jadi. Oleh itu ia boleh membuat kesimpulan reka bentuk yang betul dalam sistem bumbung boleh memperkenalkan pengudaraan rumah.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CFC	Chlorofluorocarbon
SBS	Sick Building Syndrome
ISO	International Standard Organization
CFD	Computational Fluid Dynamics
NV	Natural Ventilation

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

This research contains information to create an experimental modeling of different housing design to determine the potential of natural ventilation. The outcomes of this chapter would be the research problem background, problem statement, research objectives, scope of study, and research significance.

1.1 PROBLEM BACKGROUND

Malaysia is a tropical country which has a warm and humid atmosphere. The annual mean temperature is 26.4 ^{o}C with average daily maximum temperature of 34 ^{o}Cand a relative humidity of 70% to 90% throughout the year (Al-Tamimi, 2011). Hot and humid climate will develop a condition of thermal discomfort in a building. In most cases, air conditioning will be the key answer to solve the problem. However, the environmental effect that caused by the greenhouse gasses emitted from the air conditioning system could not be neglected as the problem keep arising in the conferences.

Natural ventilation is one of the most effective methods which can helps to achieve the cooling system and in the same time preserve the environment. The surrounding of Malaysia is very suitable for the implement of natural ventilation as there are 3 monsoon season that can guaranteed the wind flow in the country. Cooling by natural ventilation is a better energy conserving strategy in order to improve indoor thermal comfort and air quality. With a good air movement, the residence can achieve a better comfort level when staying indoors.

1.2 PROBLEM STATEMENT

Nowadays, thermal comfort has become a nation concern in Malaysia as the temperature keep arise resulted from global warming and haze attack. This issue is getting more serious and will result to health issue to the residence. From the hot atmosphere, many residence choose air conditioner to lower the indoor temperature which leads to higher energy demand. Research shows that the electricity consumption in Malaysia rises rapidly every year and the demand is expected to increase by about 30% from its present record. As the demand increases, the authorities has made their decision to increase the tariff in order to control the energy consumption. The use of air conditioner promote the emission of chlorofluorocarbon (CFC) which can leads to the depletion of ozone layer and further impacts for the Earth.

The problem of the frequency used in air conditioner increase the energy demand can be replaced by a better and natural ways by implement the usage of wind ventilation in the design of the typical housing. Natural ventilation can significantly reduce the indoor temperature and promote the flow of wind in the internal part of housing. The importance of natural ventilation are keen to be more alert when green technology are introduce in the construction sector to preserve the environment.

Further research has been done to investigate and study the availability of natural ventilation in Malaysia. As for the success of the implement, the benefit can be bulk in all aspect. Therefore, the energy consumption can be reduce significantly if the usage of wind ventilation is fully deployed.

1.3 RESEARCH OBJECTIVES

The objectives of this research are:

(i) To investigate the potential natural ventilation on typical house in Malaysia.

(ii) To evaluate the performance of natural ventilation in housing of Malaysia.

(iii) To check and compare on the results obtained.

1.4 SCOPE OF STUDY

The scopes of this study are limited to preparation, implementation, and evaluation the effect of wind ventilation in two different prototype of the roofing design.

In this research, a few scopes will be included. Firstly, in the analysis, the effect of wind tunneling is not considered as the housing are not high rise building which can affect by the wind flow. Secondly, the types of housing that will be tested for this research are set up to be single story concrete house with different opening and different roof system.

The test will be conducted in a constant wind speed (1m/s) to compare the pattern of wind flow in the house. Besides, the area for both prototype of house are same, that is 6m (width) x 12m (length) x 4m (height).Prototype A is a single story house with a normal roof system while Prototype B is a single story house with an additional jack roof system.

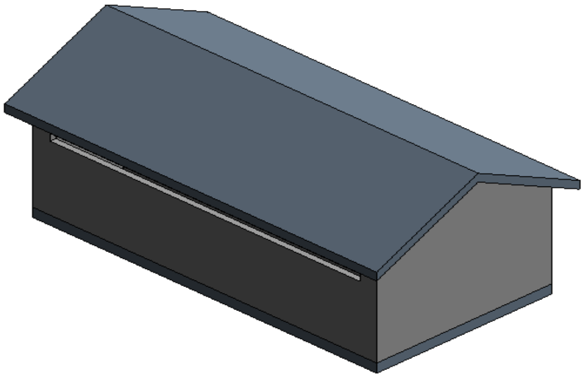

Figure 1.1: Single story housing with opening (Model 1)

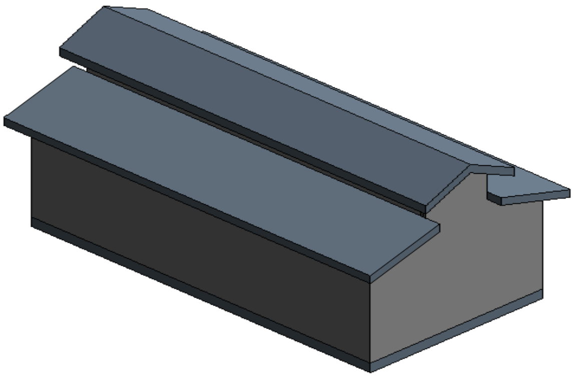

Figure 1.2: Single story housing with jack roof opening (Model 2)

1.5 RESESARCH SIGNIFICANCE

Human health and the comfort level of residence are the most important considerations that are taken into account in this research. Based on the experimental result, an effective design of roofing system in terms of wind ventilation can be created. This effective roof system is designed for a better indoor natural cooling system, making the indoor temperature lower as the wind flow through the house. The implement of ventilation is a long term effect in order to reduce the side effect for the usage of air conditioner.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter reviews relevant topics based on the research objectives. Information obtained was mainly from online resources such as ebooks, reports, articles and relevant websites. This chapter kicked start by viewing the methods of clearance and different types of boom. Then, focus will move to the discussion of design considerations, benefits, and limitations of roof system. Next, effectiveness of roof system in stimulation is discovered. The last section in this chapter will relateand compareamong the difference of my research.

2.1 INDOOR ENVIRONMENTAL QUALITY COMPONENT

According to Environmental Protection Agency's Indoor Air Quality Program, indoor air is often more polluted than outdoor air, sometimes as much as 25% more polluted, and occasionally more than 100 times as much, spend approximately 90% of their time indoor. Sick Building Syndrome (SBS), a condition that affecting office workers, typically marked by headaches and respiratory problems, attributed to unhealthy or stressful factors caused by poor ventilation in the working environment has marked one of the top five public health risks which can cause lower productivity and health problem.

The quality of the indoor environment can bring significant negative effect to the building occupants. A good quality indoor environment can result in the increase of satisfaction among occupants, enhanced productivity as well as to reduce the health issues and lower the operation cost.

The Department of Building Services Engineering of Hong Kong Polytechnic University has listed down the terms and conditions which can be used to determine the quality of indoor environment (1998). A good quality of indoor environment should have the following factor:

(i) Indoor air quality which refer to the level of freshmen, health and comfort, and related sensory immunity to any chemical or toxicological effects of compounds within the air;
(ii) Ventilation which facilitates the naturally occurring ventilation and exhausts stale air;
(iii) Thermal comfort which refers to the temperature, to the air velocity, to the humidity and to the insulation;
(iv) Noise which relates the unwanted sound from outsides, from indoors, to sounds caused by vibration and;
(v) Lighting comfort that indicates the fenestration, the luminance, the ratio of luminance, as well as the reflection of the colour factors

2.2 THERMAL COMFORT

Thermal comfort is defined as the condition of mind that expresses the satisfaction on the thermal environment by the International Standard Organization (ISO 7730). It is an important measurement that is used to measure the indoor quality for the occupants. Thermal environment are usually considered together along with other similar feature such as air quality, light and noise level in order to obtain and determine the indoor comfort level. In order to maintain the indoor thermal comfort, two conditions are crucial and must be satisfied to obtain the optimum environment. The first condition involves the coincidence appropriate environmental factors while the second condition involves the fulfillment of the energy balance in the body temperature.

The environmental factors mentioned means the radiant temperature, air speed, and relative humidity while for the energy balance of body temperature include the occupant activity and clothing level (Nicol, 1995). These factors contribute to the parameters and factors in order to evaluate thermal comfort.

Thermal mass is defined as the ability of a material to absorb heat energy. Appropriate use of the thermal mass makes a big difference to comfort level, as well as to the heating and cooling of the house in a natural methods. The usage of high thermal mass materials for the construction in hot and humid climate country like Malaysia is generally not encouraged due to their high difference between the temperatures of day and night. In construction, high thermal mass material refer to bricks and concrete which can holds the heat in a longer time and release it slowly, in adverse, low thermal mass material such as timber can respond quickly to temperature and can have a better and more desirable indoor temperature compare to bricks and concrete. Passive cooling in generally better and works more effective in low mass building of hot humid climates country like Malaysia (Reardon, McGee & Milne, 2005)

The building materials and the building design form make up a system referred to the building envelope. This can be utilized for optimal thermal comfort within the house to allow passive cooling. This process maximize the efficiency the wind flow in order to allow the heat lost from the house and in the same time prevent heat gain from the external environment. The heat flow in housing are depends on the design of house and the opening of the house. The internal layout contribute to the distribution of heat in housing while the air movement and cooling breezes promote the loss of heat from the house.

Reardon et al., 2005 have suggested that a list of steps that can be taken into account in order to assist the passive cooling process to occur. The lists are shown below:

(i) Orientation to capture cooling winds should be given careful consideration since high humidity levels in such hot humid climates can restrict a person’s ability to cool down via evaporation;

(ii) Open floor design should be in priority as to reduce the possible barriers that can reduce and affect the air flow and cooling system in house;

(iii) Bedroom should be the first priority in terms of orientation and access to good ventilation. Upstairs level are not recommended to for bedroom purpose as for the temperature will remain hot at night;

(iv) Ceiling fan is a better choice in terms of lower cost compared to air conditioner which can provide ventilation and air movement in the room;

(v) The installment of window must be in appropriate size and shape. The design of louvers and casement will affect the efficiency of natural ventilation while fixed glass panel should be avoided as no air movement are allowed;

(vi) Double glazing window is another choice as for restricting heat gain in dwelling;

(vii) Insulation should be included in the design of roof as well as wind-driven extractor fans in order to remove hot air from the space between the ceiling and the roof. This method is to enhance the cooling at night;

(viii) Ensure sun protection on exposed walls and windows through shading from planted vegetation or other green construction method;

(ix) Maximize the use of outdoor planting designs to leads the air movement to the housing instead of around the building;

(x) Higher structure is more exposed to the air movement. The height of the building are advised to be set higher to allow ventilation assist in cooling;

(xi) Usage of light coloured material and paints on external walls in order to reflect the heat from sun.

(Reardon et al., 2005)

2.3 CLIMATE IN MALAYSIA

The characteristic features of the climate of Malaysia are uniform temperature, high humidity and over rainfall with generally light wind throughout the whole year. It is extremely rare to have a full complete clear sky in a full day even it is during a period of drought as the country are located near to the equator. On the other hand, it is also rare to have a situation which completely no sunshine and continuous raining except for the period during the northeast monsoon seasons.

Though the wind are generally light and variable, however there are some uniform periodic change in wind flow patterns over the country. Based on the changes, there are 4 seasons of monsoon can be distinguished, which is the southwest monsoon, northeast monsoon and two other short period of inter-monsoon seasons. The climate in the country is warm throughout all the year with a temperature ranging from 21ºC to 34ºC in the lowlands and the temperature will be as low as 16ºC in the highlands. The average temperature is 26.4ºC with a maximum temperature in the day is 34ºC.

In the country there are two different seasons: monsoon season and dry season. The dry season starts along with the southwest monsoon, which is from May to September. The weather is hot and the humidity is high during the dry season with an average temperature of 35ºC in the day and 25ºC at night. There are only very less rainfall intensity during the dry season. In the other hand, the rain season of Malaysia starts in the middle of November until March which leads to heavy rainfall especially to the east coast of Peninsular Malaysia and also western Sarawak. In the east coast of Peninsular Malaysia, rain arise from October to February and also to the region of Sabah and Sarawak. While in the same time for the west coastal region, the rain season starts from April until November. The annual average precipitation in depth in the country is reported to be 2875mm. (Worldbank, 2014)

2.4 COMPUTATIONAL FLUID DYNAMICS (CFD)

Computational fluid dynamics, usually abbreviated as CFD, is a branch of fluid mechanics that uses numerical analysis andalgorithms to solve and analyze problems that involve fluid flows. Computers are used to perform the calculations that are required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions. A better solutions can be achieved by using a higher speed computer. Initial experimental validation of such software is performed using a wind tunnel with the final validation coming in full-scale testing.

In computational modeling for turbulent flows, one common objective is to obtain a model that can predict fluid velocity and to validate the pattern of wind flow, for use in engineering designs of the; the system being modeled. For turbulent flows, the range of length scales and complexity of phenomena involved in turbulence that cause most modeling approaches prohibitively expensive resolution required to resolve all scales involved in turbulence is beyond what is computationally possible. The primary approach in such cases is to create numerical models to approximate unresolved phenomena. This section lists some commonly-used computational models for turbulent flows. Turbulence models can be classified based on computational expense, which corresponds to the range of scales that are modeled versus resolved (the more turbulent scales that are resolved, the finer the resolution of the simulation, and therefore the higher the computational cost). If a majority or all of the turbulent scales are not modeled, the computational cost is very low, but the tradeoff comes in the form of decreased accuracy. In addition to the wide range of length and time scales and the associated computational cost, the governing equations of fluid dynamics contain a non-linear convection term and a non-linear and non-local pressure gradient term. These nonlinear equations must be solved numerically with the appropriate boundary and initial conditions.

2.5 PREVIOUS RESEARCH ON WIND ENVIRONMENT

M. Haase and A. Amato (2009) have done a research in order to determine the important factor, which is the climate condition with respect to thermal comfort in buildings and the impacts of building location and climate and orientation on thermal comfort. With the help of computational dynamic stimulation, the different hourly weather data were investigated and it was showed that NV had a good potential in tropical climates but not in subtropical climates.

Tetsu Kubota and Supian Ahmad (2005) revealed that the significance rise in the usage of non-renewable energy and promote a saving methods to improve the thermal environment at the neighborhood level. Several wind tunnel tests were presented on selected areas in Johor Bahru Metropolitan City. From the research, it shows that natural wind flow was one of the most effective renewable energy to improve the thermal environment at neighborhood level.

Tetsu Kubota and Supian Ahmad (2006) determine the strategies that reduce energy consumption at neighborhood scale, targeting especially a reduction in the use of air conditioners. It was showed that the majority of terrace house cases did not meet the required criteria, under the respective local climate conditions.

Gao Caifeng (2011) showed that the optimum location for the opening to promote movement of air should be in opposite direction or perpendicular to each other. It showed that the sensitivity of natural ventilation performance to the change of the configurations parameters, window positions was the most significant, followed by building orientation and door position.

Panagiota Karava (2008) has determined that the area of opening of inlet should not be larger than outlet to avoid high indoor wind speed. A larger opening of outlet are recommend to promote the suction effect on the leeward wall and in the same time remain the indoor wind speed within a comfort limit.

2.6 CONTRIBUTION OF RESEARCH

The research that I am about to commence are using two types of different prototype which include the internal barrier to stimulate and study about the pattern of air movement. The reason for the implement of internal barrier in the research is to have a better compares between the air movement in the inlet and outlet. The position of inlet and outlet are in opposite direction as per recommended in the previous study. The area of outlet is larger than the area of inlet to prevent the discomfort caused by the indoor wind speed.

CHAPTER 3

RESEARCH METHODOLOGY

3.0 INTRODUCTION

This chapter explains the entire methodology of the research. Elements that will be discussed are the research experiment, flow chart, and procedures for carry out the experiment. In this study, REVIT 2014 is used to design and construct on the typical house model that used in the stimulation using COMSOL Multiphysics 4.2a. They can divided into 3 steps, there are pre-processing, solution and post-processing. In pre-processing stage, the model of typical house is designed using REVIT 2014. After modeling, the boundaries condition of the model need to be added and the wind speed can be applied for analysis. In this case, the wind speed used for both model is set to be fixed in value and direction. Under post-processing stage, the results can be generated and assessed for each model.

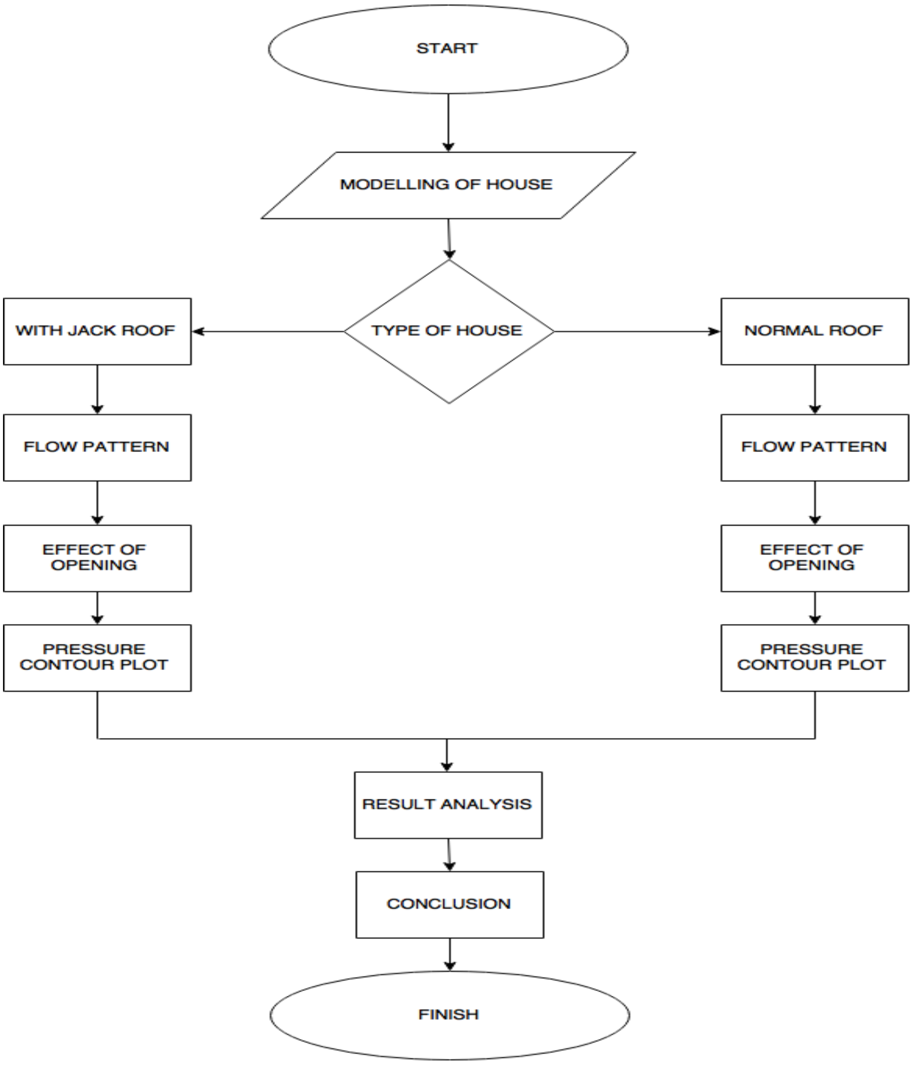

Figure 3.1: Flow chart of research experiment.

3.1 PRE-PROCESSING

In this study, the prototype of housing is modeled by using REVIT 2014. The wall is the first element that is drawn in the software. After that, the slab and roof is added to the prototype. Lastly, the opening of the each prototype is added.

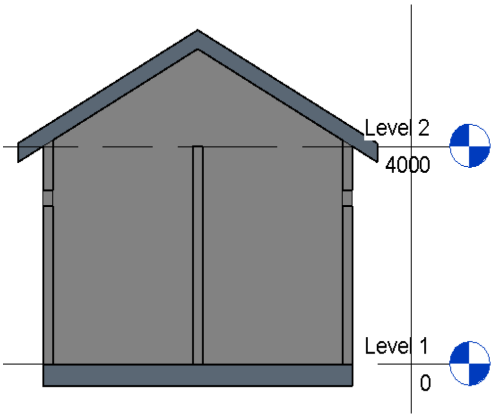

Figure 3.2: Cross Sectional View on Model 1.

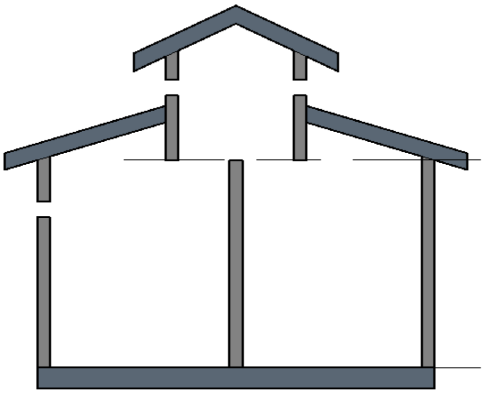

Figure 3.3: Cross Sectional View on Model 2.

3.2 SOLUTION

3.2.1 ELEMENT

The element used in this study is 3 dimensional (3D) and it is a study of turbulent flow. The physics are assumed to be in stationary as the housing does not exhibit any movement in the effect of air flow.

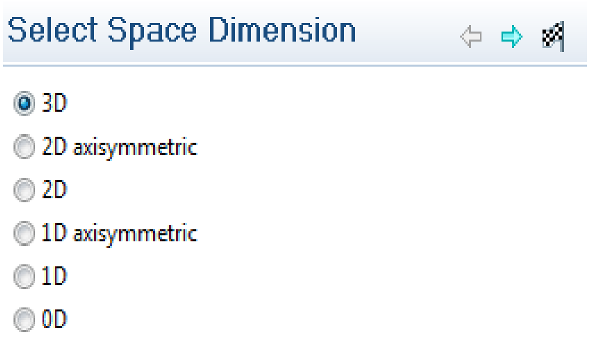

Figure 3.4: 3 Dimensional Setting is selected.

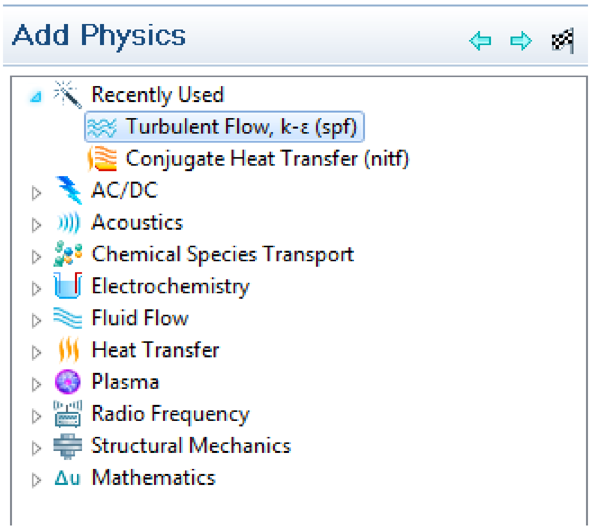

Figure 3.5: Select turbulent flow for stimulation.

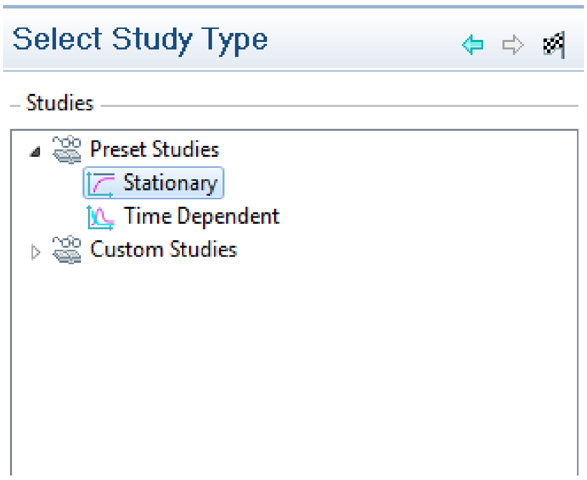

Figure 3.6: Set the studies to be in stationary.

3.2.2 MODELING

The model is imported from REVIT 2014 as shown in the figure. They can be added through Import > Browse > Selected File > Import. As shown in figure 3.6 to figure 3.8, the modelsshown in the COMSOL Multiphysics 4.2a are the same as the modeling through REVIT 2014.

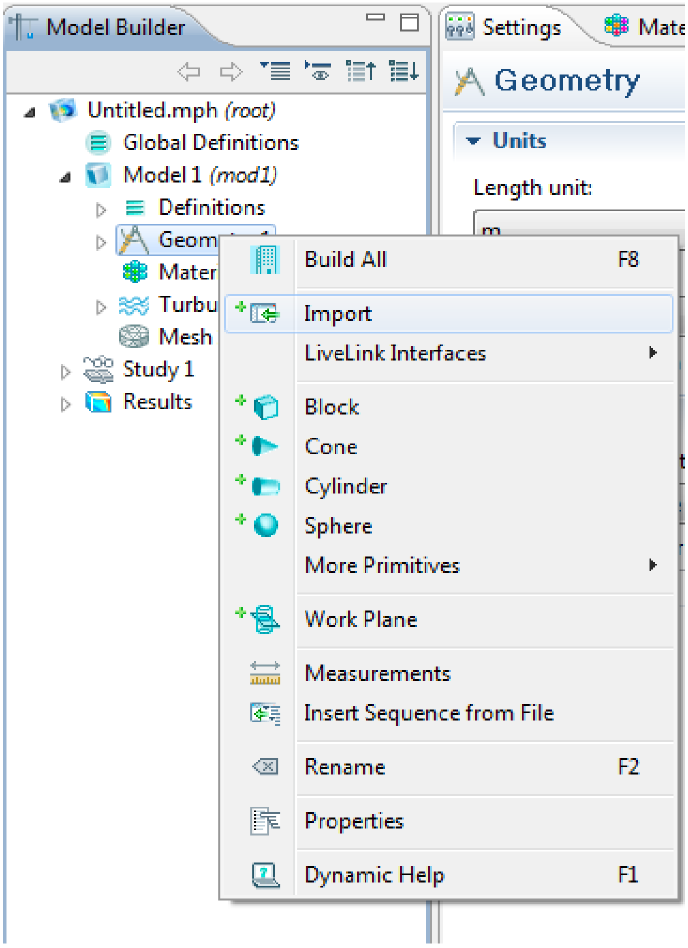

Figure 3.7: Select Geometry > Import.

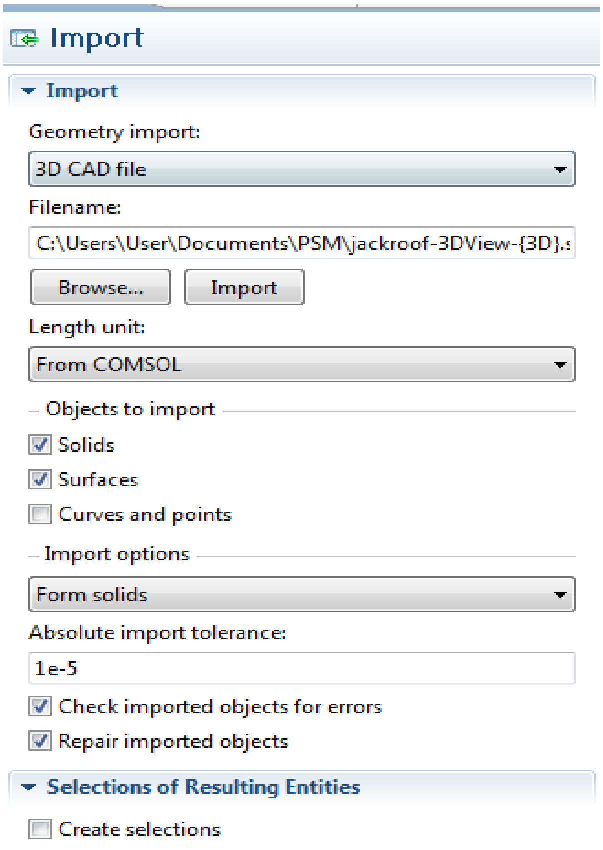

Figure 3.8: Import the selected model.

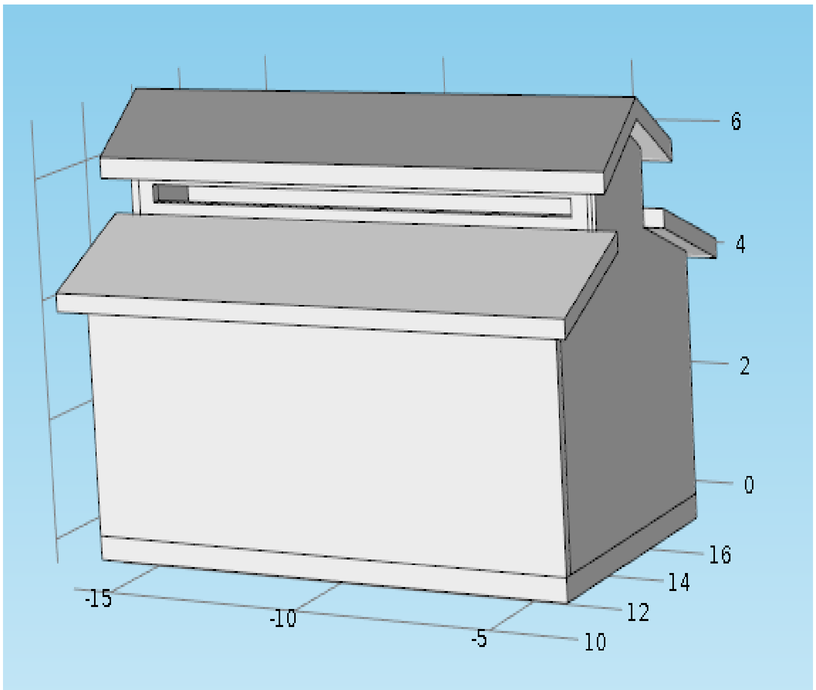

Figure 3.9: The model imported to COMSOL Multiphysics 4.2a.

3.2.3 MATERIAL PROPERTIES

The material of the element tested is added to the physics. As shown in figure, the material can be added by Material > Open Material Browser > Built-In > Concrete > Add Material to Model > Select Domain.

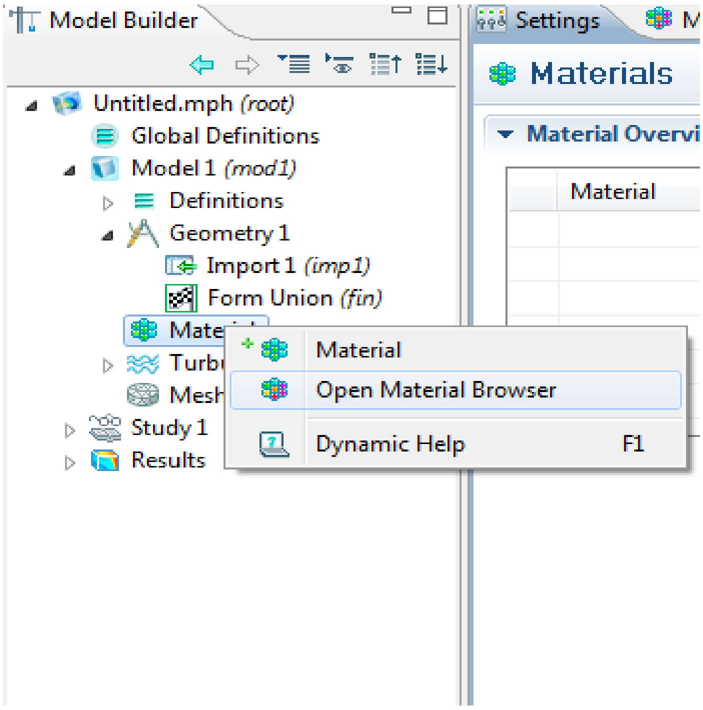

Figure 3.10: Select Material > Open Material Browser.

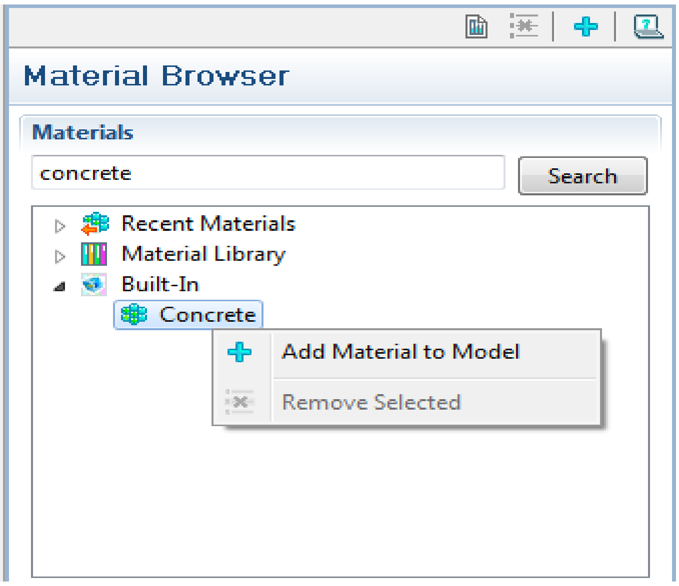

Figure 3.11: Concrete is selected for the material of housing.

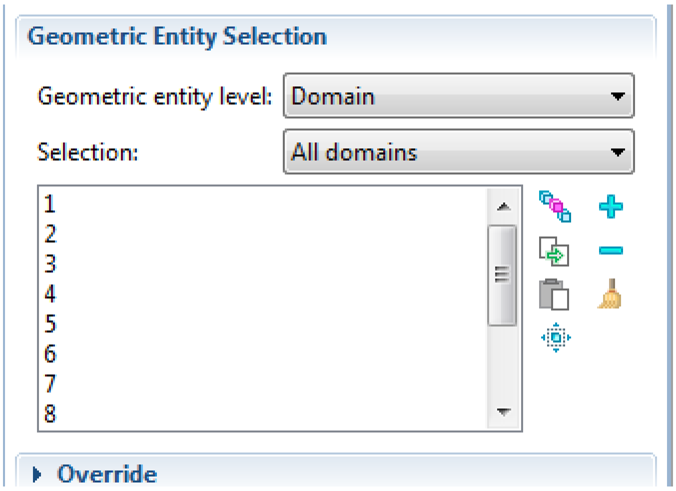

Figure 3.12: All the domain is selected for concrete.

Table 3.1: Material Properties of Concrete.

Name	**Value**	**Unit**
Density	2300	Kg/m^3
Coefficient of Thermal Expansion	10e-6	1/K
Thermal Conductivity	1.8	W/(m*K)
Young's Modulus	25e9	Pa
Poisson's ratio	0.33	1

3.2.4 INLET AND OUTLET

In order to assess the flow pattern of the wind, the inlet and outlet of the air flow can be added. From Model Builder > Turbulent Flow > Inlet > Select Domain > Set Velocity. In this study, the velocity of the wind is set to be 1m/s as to determine the potential of air ventilation in the advance of wind pattern without considering the effect of the velocity of air flow to the house.

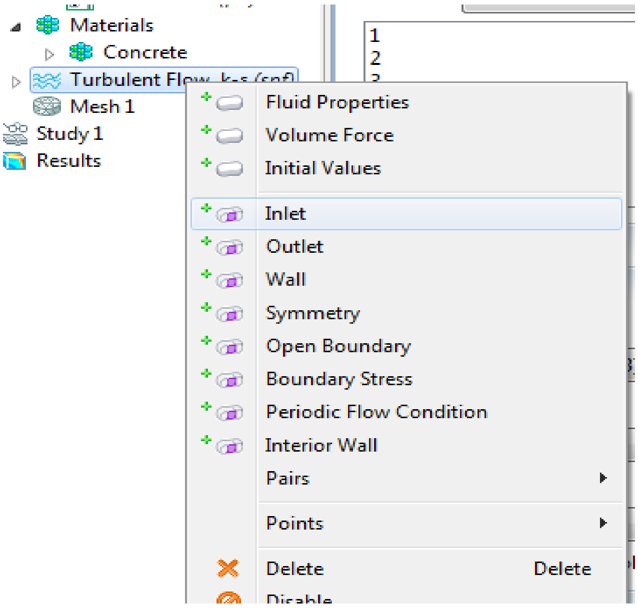

Figure 3.13: Select Turbulent Flow > Inlet.

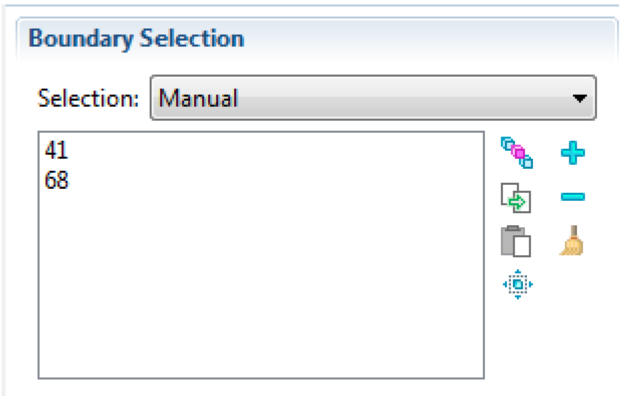

Figure 3.14: Select faces of wall which act as the inlet for the ventilation.

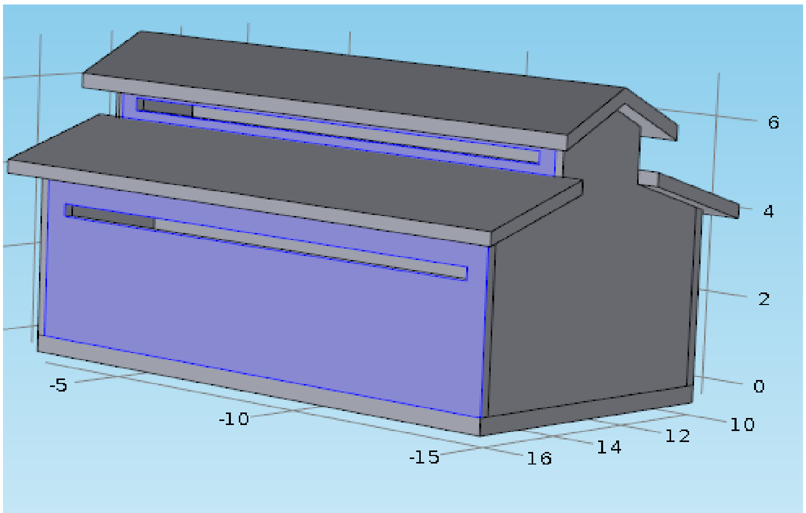

Figure 3.15: Blue colour zone indicate the inlet zone.

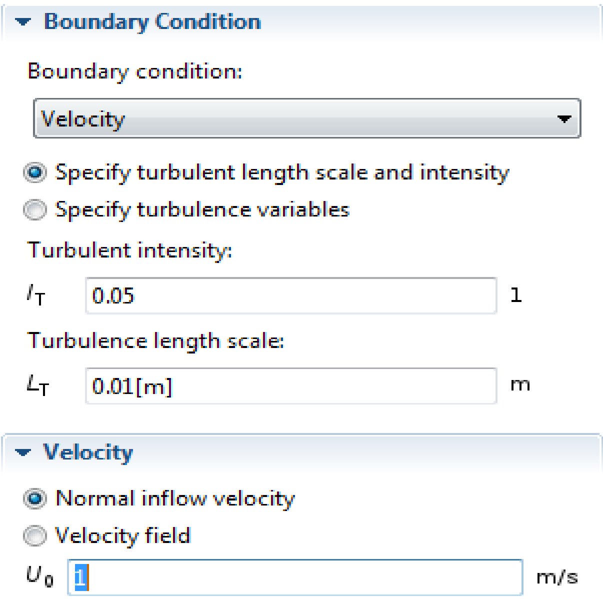

Figure 3.16: Velocity of the ventilation is controlled in 1m/s.

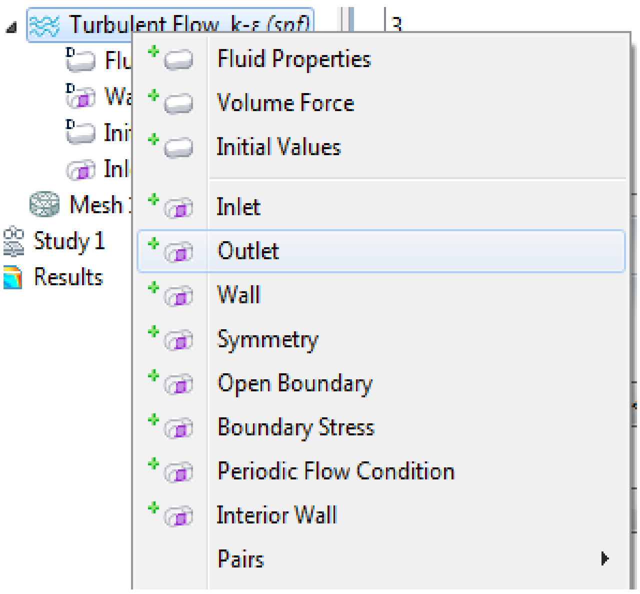

Figure 3.17: Select Turbulent Flow > Outlet.

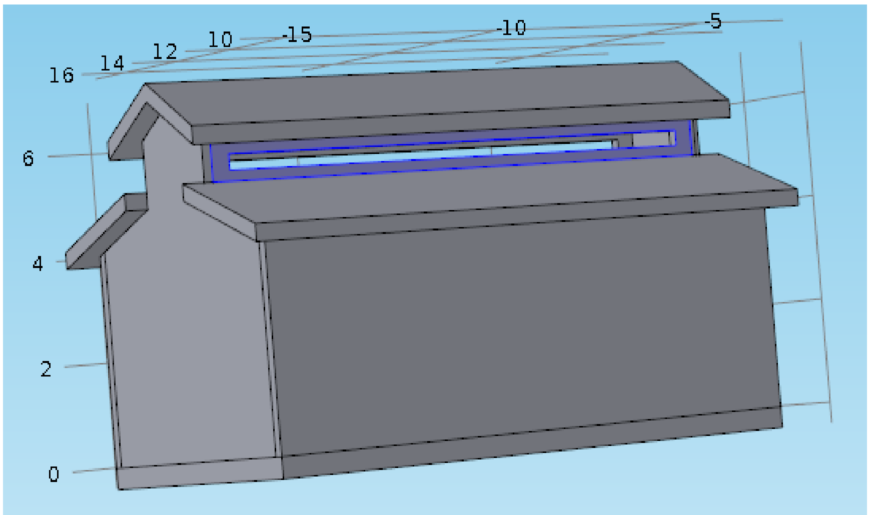

Figure 3.18: The blue colour zone indicates the outlet.

3.2.5 MESHING

Meshing is used to divide the whole model into a smaller element for the ease of analysis. In Comsol Multiphysics, tetrahedral meshing is chosen for a more accurate and significance results. Form the Model Builder > Meshing >Free Tetrahedral > Size > Element Size > Normal> Build Selected. The steps are shown in the figure below.

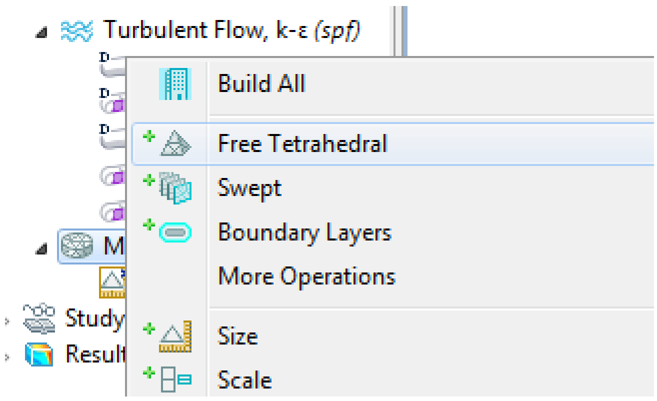

Figure 3.19: Select Meshing > Free Tetrahedral.

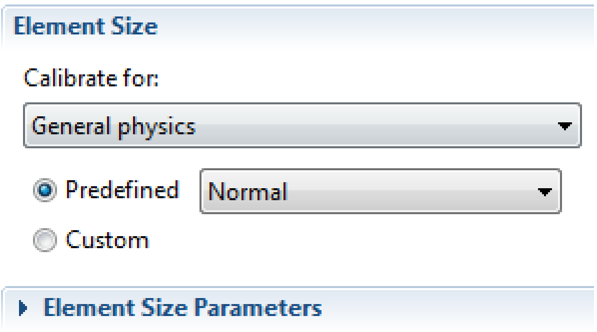

Figure 3.20: Select General Physics > Normal Predefined.

3.2.6 ANALYSIS

After the setting of the element, the analysis start by computing wind flow on the model. The flow of the wind pattern could not be seen during the process and can only be reviewed once the calculation and stimulation have done.

3.3 POST-PROCESSING

3.3.1 VELOCITY

After the solution is done, the velocity of model after the analysis can be plotted through Model Builder >Velocity > Slice 1. As shown in the figure, the data of the velocity can be presented by xy-plane, yz-plane, and zx-plane. The number of slice can be selected in order to compare the air flow pattern at different zone.

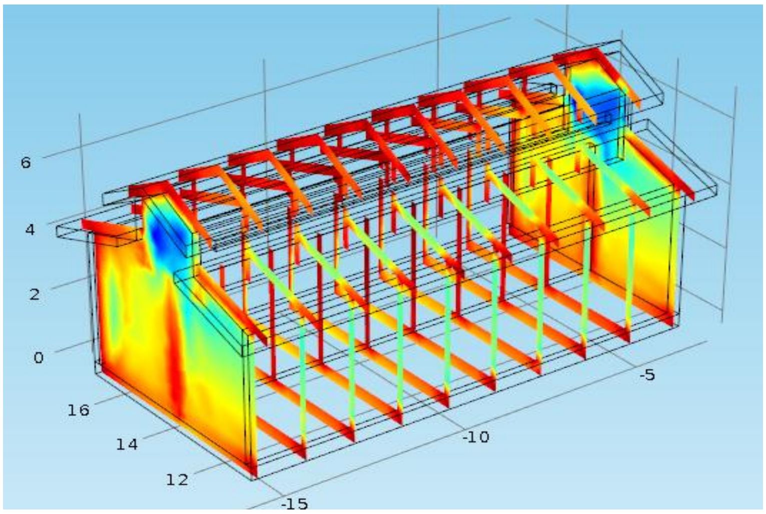

Figure 3.21: 10 slices of the result shown in zx-plane.

3.3.2 PRESSURE

From Model Builder > Pressure, it can be shown that the difference in pressure in the effect of the wind flow. Figure shows that the variety in pressure.

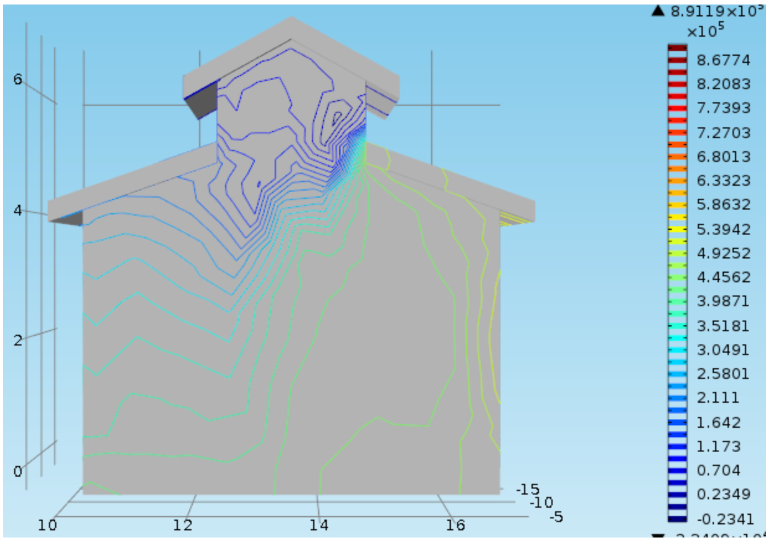

Figure 3.22: The pressure contour line distribution in the housing under the effect of ventilation.

CHAPTER 4

RESULT AND DISCUSSION

4.0 INTRODUCTION

This chapter explains on the results that are extracted from the COMSOL Multiphysics through post-processing after the analysis is done. After the application of wind flow on the prototype, the results are then plotted and discussed. The results that can be extracted are wind velocity and the pressure contour after the analysis is discussed.

4.1 FLOW PATTERN

The figure is the air flow pattern for the different roof design in housing respectively. When there is an opening, the blue colour zone which represents the maximum air flow is more focus on the opening of the housing. Besides, the red colour zone which represents the minimum air flow shows a higher temperature in the indoor environment. Jack roof design, in this case, shows better ventilation as compared to normal roof design. The blue zone that indicate a better flow rate can be seen in the jack roof area which shows that the potential of natural ventilation in jack roof system. While for the normal roof system, although the initial flow rate of air is same, the potential of natural ventilation is not significance. From the figure, it shows that the air flow is restricted in the windward zone because of existing of the interior barrier (wall).

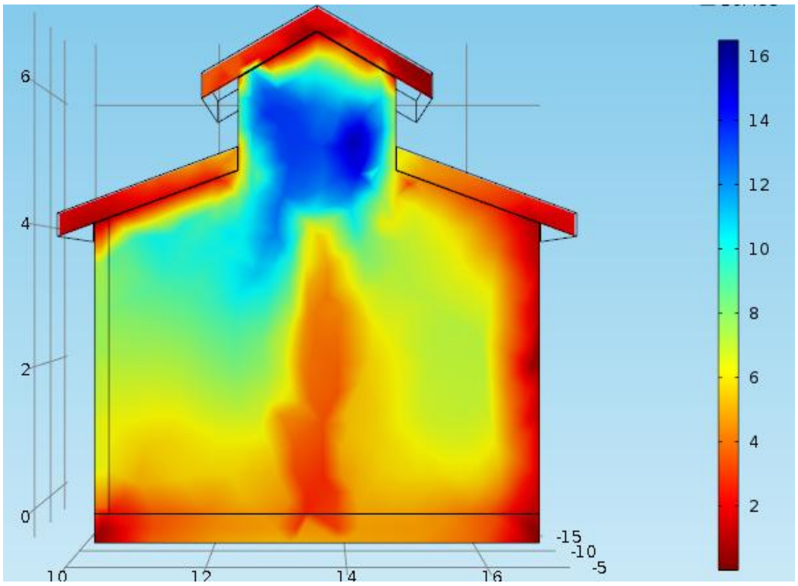

Figure 4.1: Flow pattern in jack roof housing (model 2)

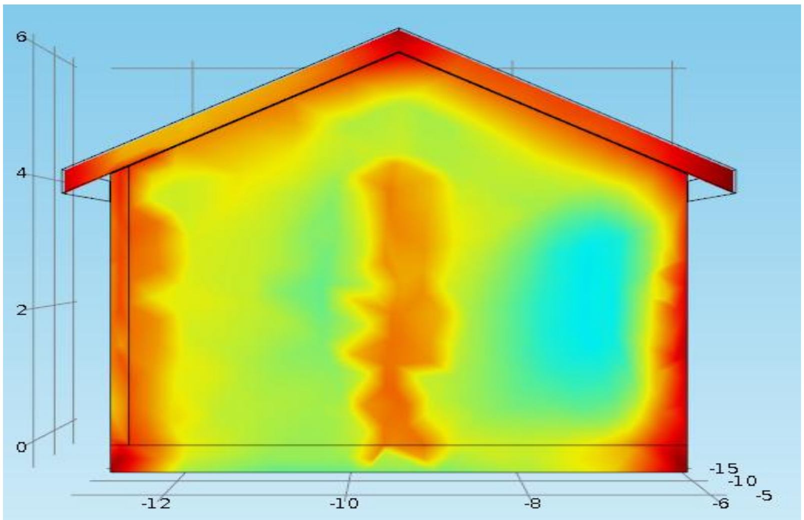

Figure 4.2: Flow pattern in normal roof housing (model 1)

4.2 EFFECT OF OPENING

Figure 4.3 – 4.4 shows that the area of opening for the inlet for each model of housing with different roof system. The figure shows that the jack roof system with a larger opening enhance the potential of natural ventilation as compared to housing model with normal roof system. The red arrow of the figure indicate the movement of ventilation in the model. It can be seen that in the jack roof system, the air is sucked up from the indoor environment in the leeward zone. This phenomenon is named as passive ventilation which is more efficient compared to normal ventilation.

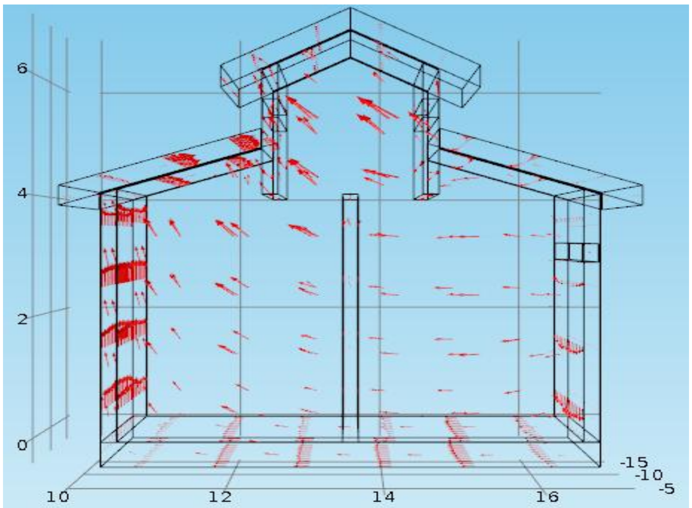

Figure 4.3: Air movement in model 2.

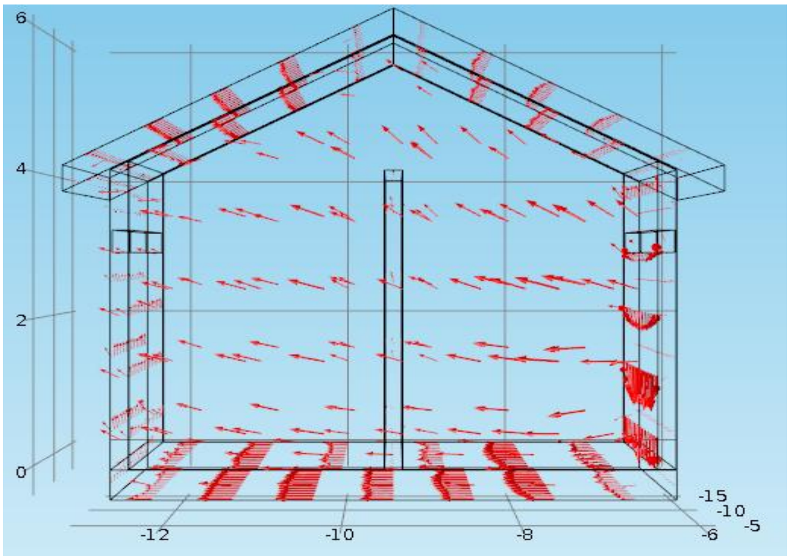

Figure 4.4: Air movement in model 1.

4.3 PRESSURE CONTOUR PLOT

The figure 4.5 – 4.6 show the contour plot for the changes in pressure in the indoor environment of the house after the application of natural ventilation. As shown in figure, the variation of the pressure is not significant, this proved that the potential of natural ventilation can be considered as poor because the sucking effect of passive ventilation at the leeward zone is not happening. In figure, for the design of jack roof system, the contour plot of the pressure can be seen varies from the lower part zone to the upper part zone. The blue colour line zone indicates the low pressure zone that performs as the key point of the ventilation. The passive ventilation is enhanced as the suction of air is promoted by the pressure.

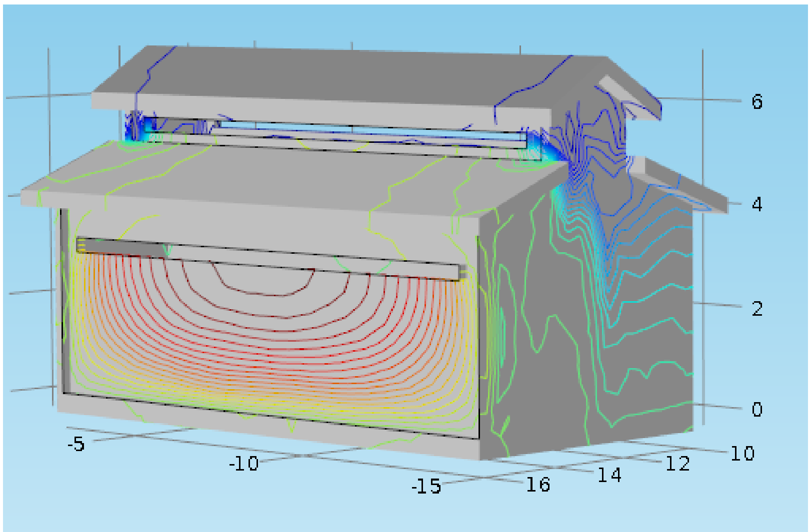

Figure 4.5: Pressure contour distribution in model 2.

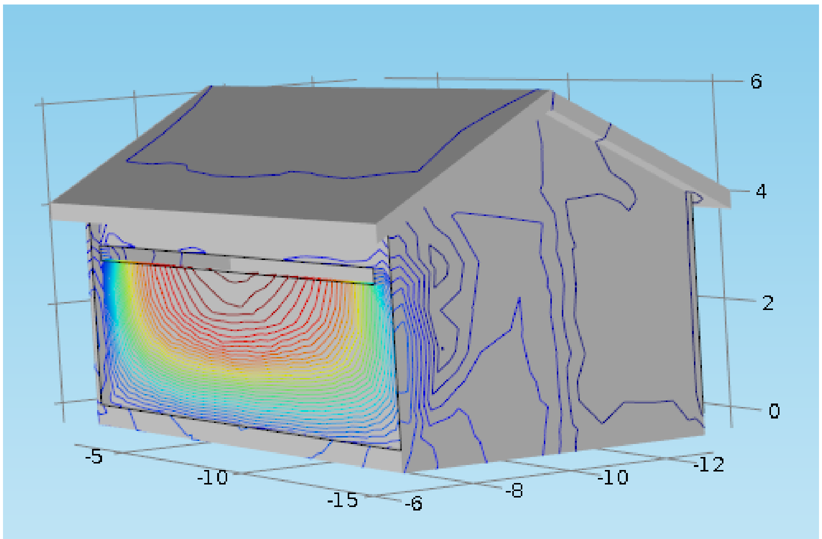

Figure 4.6: Pressure contour distribution in model 1.

4.3 SUMMARY

This part justifies the importance of the research to the analysis and evaluates the potential of natural ventilation to the typical house in Malaysia. According to the data collected, for jack roof system, it showed that three types of analysis; flow pattern, effect of opening and pressure contour plot have good performance in the effect of indoor cooling. When the wind blow to the house, the pressure of the inlet will increase, the indoor air will tends to escape from the outlet which has a lower pressure. This effect is named as passive ventilation. In the house, the existence of the barrier will block the flow of the wind to the other side of house. Hence, the suction effect on the leeward face of the house can help to promote the cooling effect in whole house.

Nevertheless, there is a different situation in the normal roof system. As referring to figure 4.2, 4.4, 4.6, normal roof system has a lower performance on the effect of natural ventilation. The reason of the result is due to the pressure change caused by the normal roof system is not significant. Therefore, it is less effective in the internal cooling when compared to the jack roof system. The internal wall of the house block the flow of the house and in this case, the ventilation of the wind can only be achieved in the windward side.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.0 INTRODUCTION

This chapter will explicate the results of hypothesis testing that mentioned in the previous chapter.Based on the objectives of the study, conclusion for the research is shown in this chapter. Limitations and recommendations for the research will be discussedfor the researcher in the future analysis in this chapter as well. This study is aimed to assess the potential of natural ventilation on typical housing design at the same time to increase thermal comfort as well as the usage of natural ventilation in daily life.

5.1 RECAPITULATIONS OF RESEARCH

The aim of this research is to determine the potential of natural ventilation on typical housing in Malaysia which can provide a better thermal comfort for the residences. The problem statement, research objectives and research questions that have been explained in Chapter 1, Chapter 2 focused on the overview of the study of natural ventilation. The second chapter explained on the effect of natural ventilation that can cause in reducing the indoor air quality and in the same time reducing green house gases that are emitted through air-conditioner. Subsequently, the relationships between the independent variables and dependent variables were formed. This research answered for the following objectives:

(i) To investigate the potential natural ventilation on typical house in Malaysia.

Two types of roof design which are jack roof system and normal roof system were tested for the better flow of air which can enhance the ventilation of housing. Both roof designs showed the flowing of air in the housing, however, the effect of ventilation in the normal roof system is not significant. The effect of natural ventilation in the jack roof system is better as the air is being sucked up and passive ventilation is promoted.

(ii) To evaluate the performance of natural ventilation in housing of Malaysia.

Based on the literature review, an experiment was done at the Johor Bahru city shows that the increasing usage of energy consumption at neighborhood area and the importance of the usage of renewable energy to improve the thermal environment (Tetsu Kubota, 2006).Hence, in my research, I have used two types of roof system that are commonly seen in Malaysia to evaluate the performance of natural ventilation. From the stimulation, jack roof system shows the highest effect and a better performance.

(iii) To check and compare on the results obtained.

This objective aimed to compare on the roof design in Malaysia's typical house. In order to test the hypothesis, 2 different roof designs are stimulated for the ventilation. The results of the stimulation have fulfilled the research objective by showing that the jack roof system has a significance influence on the performance of natural ventilation.In Malaysia, most of the houses use normal roof system which is proved to be less effective than the jack roof system from the results and data obtained from the stimulation.

5.2 DISCUSSION

Natural ventilation is a type of renewable energy sourcethat can be used to replace the current air-conditioner usage and improve the thermal comfort among the neighborhood area. The consideration of natural ventilation is crucial in the design of roofing system in order to optimize the effect of indoor cooling and passive ventilation. From the results and data obtained, it shows that the roof system in normal housing in Malaysia do not perform well in the aspect of performance in natural ventilation. Jack roof system in this case shown a better efficiency and the implementation in housing in Malaysia can helps to reduce the emission of CFC gases to the ozone layer.

5.3 RECOMMENDATIONS FOR FUTURE RESEARCH

Consequently, some recommendations need to be considered in order to improve this study for future research purpose. The height level of the housing can be increased to determine the effect of natural ventilation at the different level of the house. In this research, single storey housing is chosen for the purpose of compares on the effect of different roof system. Besides, wind tunneling effect is not considered in this study as the neighborhood housing areas are not considered as high rise building.

In addition, there are a few consideration has to be taken in to install the position of the opening. The wind direction will affect the performance of the ventilation as the distribution of the pressure contour may not be the same. In this case, the suction effect in the leeward side might lose its effect on the indoor cooling process. Besides, the height of the opening should be considered as a different height of the opening can cause a different in wind pattern. The different of wind pattern will bring effect to the ventilation of the housing.

Last but not least, the resistance of the building against the wind velocity should be considered. This is because high wind velocity will cause the failure in building such as roof collapse cases that are happen in Malaysia recently. It shows that wind tunneling effect should be considered depends on the surrounding building in the neighborhood area. Under the effect of wind tunneling, the velocity of the wind will be varies from the data that is obtained from the metrological station.

5.4 CONCLUSION

As a conclusion, the objectives of this research have been achieved.After the analysis of result, it can be concluded that jack roof system can be implement in the design on typical house in Malaysia with a good performance of potential in natural ventilation. The performance of natural ventilation in normal roof system currently in Malaysia is not significant and can cause a higher energy consumption. Jack roof system can be implemented in the design of any housing in Malaysia which can achieve a better thermal comfort and lower the effect of green house gases done to the ozone layer.

REFERENCES

Al-Tamimi, N. a.M., & Syed Fadzil. S. F. (2011) "Thermal Performance Analysis for Ventilated and Unventilated Glazed Rooms in Malaysia", Indoor and Built Environment, 20(5), 532-542

Department of Standards Malaysia (2007) "MS1525:2007 Code of Practice on Energy Efficiency and Use of renewable Energy". Malaysia.

Gao Caifeng (2011) "The study of Natural Ventilation in Residential Buildings"

M. Haase and A. Amato (2009) "An Investigation of the Potential for Natural ventilation and building Orientation to Achieve Thermal Comfort in Warm and Humid Climates"

Murakami, S. et al. (1985) "Criteria for Assessing Wind-induced Discomfort Considering Temperature Effect", J. Archit. Plann. Environ. Eng., AIJ, No.358,9-17 (in Japanese).

Murakami S., Kato S., Akabayashi S., Mizutani K. and Kim Y. D. (1991) "Wind Tunnel Test on Velocity-pressure field of Cross-ventilation with open Windows", ASHRAE Transactions 97 part 1: 525-538.

Panagiota Karava (2008) "Airflow Prediction in Buildings for Natural Ventilation Design: Wind Tunnel Measurements and Stimulation"

Tetsu Kubota and Supian Ahmad (2005) "Analysis of Wind Flow in Residential Areas of Johor Bahru City"

Tetsu Kubota and Supian Ahmad (2006) "Wind Environment Evaluation of Neighborhood Areas in Major Towns of Malaysia"