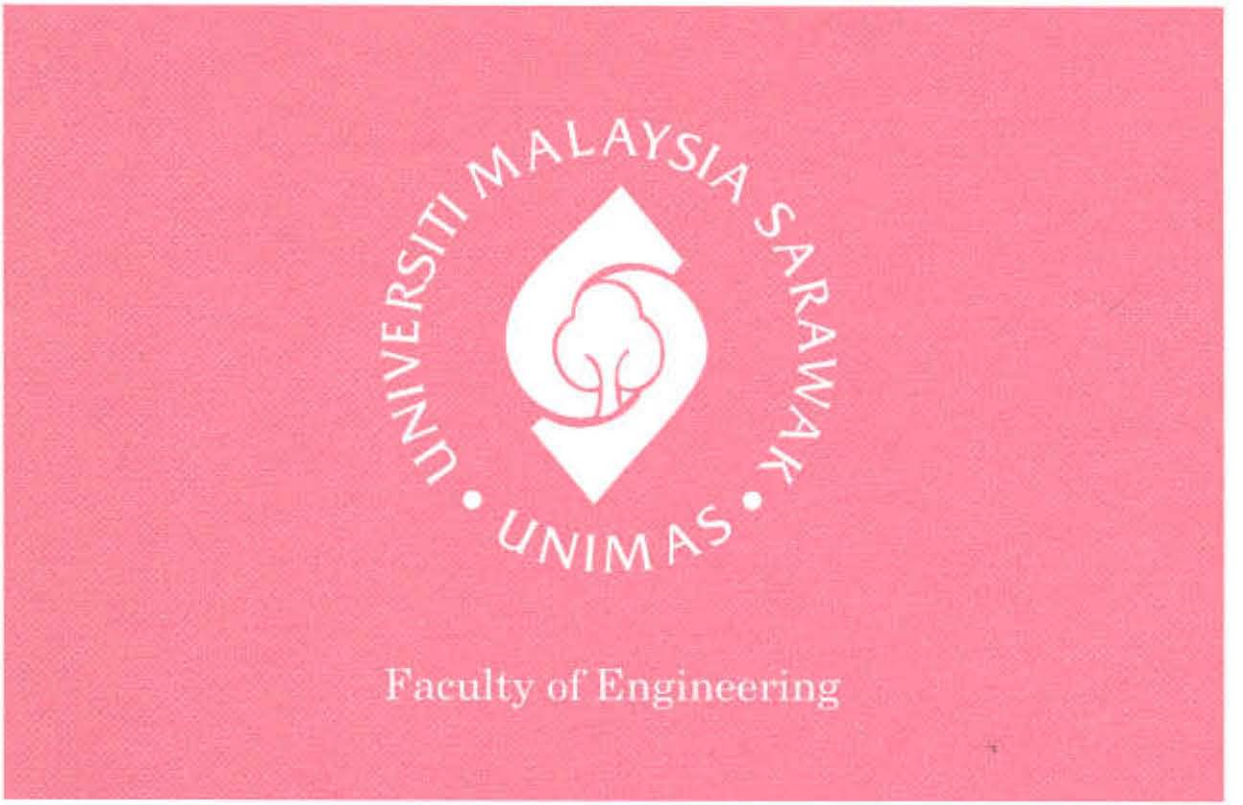

THE EFFECT OF GREEN ROOF TECHNOLOGY AND CONVENTIONAL ZINC ROOF TO DIFFERENT BUILDING MATERIALS IN TROPICAL CLIMATE

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Bachelor of Engineering with Honours
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THE EFFECT OF GREEN ROOF TECHNOLOGY AND CONVENTIONAL ZINC ROOF TO DIFFERENT BUILDING MATERIALS IN TROPICAL CLIMATE

KHOR JO ANNE

Thesis is submitted to

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To my beloved family and friends

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ABSTRACT

The aim of this research is to compare and identify the effect of green roof technology and conventional zinc roof to different building materials in tropical climate. Four building models measuring 0.5m×0.5m×0.5m each were built which are, wood and brick models with zinc roof and green roof for each building material respectively. The experiment was carried out by measuring the interior air temperature of each model every hour from 0800h to 1700h for five sunny days. Then, the average temperature for each model was computed. The result has shown that the average temperature differences for the brick material are higher than that for the wood material. For both materials, model with green roof has shown higher temperature compare to model with zinc roof. The results gained were affected by the inconsistency of wind and the cloud appearances during the experimentation period. Besides that, the humidity level in the models and the reflectivity of the zinc roof has caused the temperature of models with zinc roof to decrease.

ABSTRAK

Matlamat kajian adalah untuk mengkaji kesan teknologi bumbung hijau berbanding bumbung zink konvensional terhadap bahan binaan berlainan, iaitu kayu dan bata di iklim khatulistiwa. Empat model bangunan berukuran 0.5m×0.5m×0.5m setiap satu telah dibina iaitu model-model kayu dan bata dengan bumbung zink dan bumbung hijau untuk setiap bahan binaan masing masing. Eksperimen dijalankan dengan mengukur suhu udara dalaman setiap model setiap jam dari 0800h hingga 1700h selama lima hari yang mengandungi cuaca cerah. Purata suhu untuk setiap model untuk setiap jam dikira. Keputusan menunjukkan purata suhu untuk bata adalah lebih tinggi berbanding purata suhu untuk kayu. Bagi kedua-dua bahan binaan, model bumbung hijau menunjukkan suhu yang lebih tinggi berbanding model zinc. Faktor-faktor yang mempengaruhi keputusan eksperimen ini adalah kelajuan angin yang tidak konsisten dan keadaan awan yang tidak sekata. Selain itu, keputusan eksperimen ini juga dipengaruhi oleh kadar kelembapan di dalam setiap model and juga kebolehpantulan bumbung zink dan ini telah menyebabkan suhu dalaman model zink untuk turun.

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PTM	-	Pusat Tenaga Malaysia
WTI	-	Western Texas Intermediate
PAM	-	Pertubuhan Arkitek Malaysia
ACEM	-	Association of Consulting Engincers Malaysia
USGBC	-	United States Green Building Council
GBI	-	Green Building Index
BCA	-	Building and Construction Authority
MSC	-	Multimedia Super Corridor
ASTM	-	American Standard of Testing and Materials
NRAF	-	National Rent A Fence
ASEAN	-	Association of South East Asia Nations
T_1	-	Temperature (°C) of wood model with zinc roof
T_2	-	Temperature (°C) of wood model with green roof
T_3	-	Temperature (°C) of brick model with zinc roof
T_4	-	Temperature (°C) of brick model with green roof

CHAPTER 1

INTRODUCTION

1.1 Background of Green Building

Green building or known as sustainable building is defined as a building that used the least amount of natural resources during its entire life cycle. Besides that, green building also has the objective that is to protect the human health and the environment from negative impact through its recyclable and environmental-friendly building material. The popularity of the designing a green building is increasing because of the decreasing in natural resources worldwide (Brownstone et. al, 2004). Such depletion has also caused the price of the natural resources such as fossil fuels to increase rapidly causing the world to consume energy conservatively and efficiently. Based on the statistic obtained from Malaysia Energy Center (PTM), the fuel prices has been rising steadily from 2001 till reaching its peak at 2008 as shown in Figure 1.1.

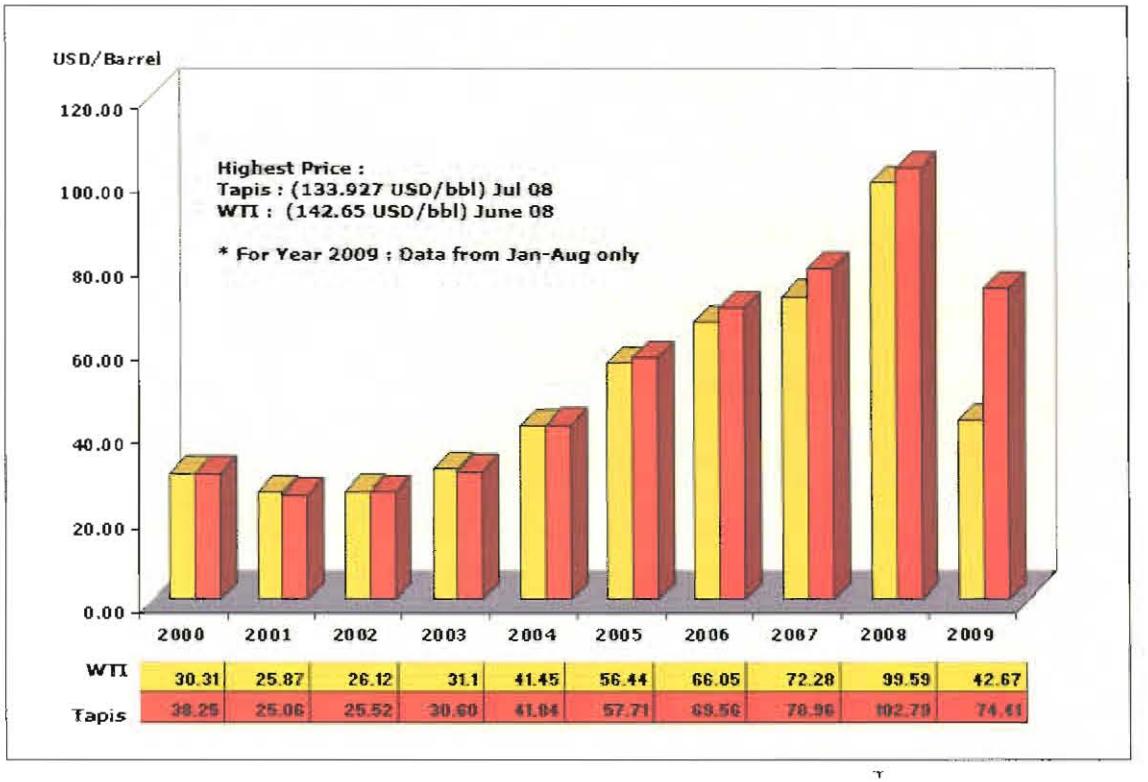

Figure1.1: Average Price of Crude Oil in Western Texas Intermediate (WTI) and Tapis crude from 2000 to 2009 (PTM, 2009)

Fossil fuels burning that are still currently the major energy contributor to human activities is the greatest source of greenhouse gases. Combustion of fossil fuels produces carbon dioxide gas that is causing the earth average surface temperature to increase as the carbon dioxide is trapping the heat from the sun.

As the sunlight reaches the earth surface, part if the energy is radiate back towards the space as infrared radiation. The radiation tends to be absorbed by the greenhouse gases in the atmosphere such as water vapor, carbon dioxide and methane. Then, the heated atmosphere will radiate the heated infrared radiation back to the earth surface and increase the earth average surface temperature and this process is known as greenhouse effect and leads to global warming.

The greenhouse gases cause the occurrence of the greenhouse effect. These greenhouse gases are emitted from the effect of development around the world as the energy needs are predominantly generated through the fossil fuels combustion such as crude oil, natural gas and coal. For example, the usage of air-conditioning in commercial and residential building has tremendous negative impacts to the environment. Therefore effort should be done to reduce the usage of air-conditioning through the usage of passive cooling methods. In addition, the generation of electricity from fossil fuel combustion could be replaced with other renewable sources such as solar power.

As the greenhouse effect is getting worse and its impact to the world ecosystem is becoming apparent, a new concept and guidelines of a more environmental friendly building was introduced by scientists and engineers. This new concept is known as Green Building (Brownstone et. al, 2004). In Malaysia, the Pertubuhan Arkitek Malaysia (PAM) and the Association of Consulting Engineers Malaysia (ACEM) introduced this concept and criteria of green building through the Malaysia's Green Building Index on 3 January 2009 (Tan, 2009). The purpose of introducing this concept is to promote the Malaysia construction and building industry towards an environmental friendly industry. In addition, it also serves to raise awareness about environmental issues and education among the public.

1.2 Problem Statement

Green building technology is currently a popular research around the world as the engineers and scientist try to reduce the energy consumption of building as part of the measure to reduce global warming (Brownstone et. al, 2004).

The concept of green building technology is to design and create buildings where the usage of natural recourses such as energy and water will keep to the minimum level. This is achieved by using renewable energy as power supply and reducing the usage of electrical equipments such as air-conditioning and lighting system. However, most of these researches done by the United States and European nations might not be suitable to be applied in Malaysia buildings scenario as Malaysia has tropical climate compare to those colder Western countries. Besides that, green building technologies has not achieve a great attention from local researchers and scientist to create the green technology that could be adapted by engineers and contractors to be applied into typical building in Malaysia.

The basic materials of buildings in tropical climate like Malaysia are made up of wood or bricks. The conventional roof of these buildings is made from zinc. As part of this project, the approach and application of green roof technology would be tested and experimented using model buildings for the wood and brick materials to gauge the effectiveness of green building technology in Malaysia.

At the end of this report, it is hope that the green building technology such as the green roof technology suggested here could be apply effectively in other buildings in Malaysia as well as buildings in other tropical countries to improve the

passive cooling while reducing usage of air conditioning and increasing energy efficiency of the buildings.

1.3 Objectives

The objective of this research is to identify the effect of green roof technology and conventional zinc roof to different building materials in tropical climate by determining the interior temperature difference of the model buildings. The building materials here refer to wood and brick. Four building models were built at the size of $0.5m \times 0.5m \times 0.5m$ each. Interior temperature of each model was taken every hour from 0800h to 1700h for five sunny days. Then, the average temperature of each model was calculated. The average temperature difference between the green roof and the zinc roof for each building materials were also computed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Green Building

Green building, also known as sustainable building is a building that used the least amount of natural resources during its entire life cycle, which include designing, constructing, maintaining, operating and finally removing. Green building must also be able to protect environment that is to bring the minimum negative impact to it. Another characteristic of a green building is to improve the quality of human health. This means that the materials used in building and operating a green building must be free from emission of toxic and poisonous gases that can harm the building occupants.

According to the United States Green Building Council (USGBC), green building is defined as the design and construction to significantly reduce or eliminate the negative impact of buildings on the environment and on the building occupants. Some criteria considered when designing and constructing the green building are site planning, water and energy efficiency, conservation of resources and materials and the quality of the surrounding environment, which include the indoor and outdoor environment.

According to the Malaysia's Green Building Index (GBI), there are five characteristic and concept of a green building. They are as below:

a) Designation of a green building helps to save energy and natural resources, recycle materials as much as possible and minimize the emission of toxic substances throughout its life cycle.
b) Green building's concept is to harmonize and integrate with the local climate, traditions, culture and the surrounding environment.
c) Green building must be able to maintain and improve the quality of humans' health and also the ecosystem.
d) Throughout its life cycle, green building must be able to use resources efficiently and increase workplace productivity.
e) Company or organization of the green building must be responsible to each and every part of the building.

Malaysia's first green building is the G-Tower. The G-Tower has been certified by the Building and Construction Authority of Singapore (BCA) on March 2008 and is rated grade A++. Singapore's BCA is an organization under the Singapore's Ministry of National Development. Its main focus is on the development excellent buildings, structure and infrastructure for Singapore. Figure 2.1 shows the view of the G-Tower.

Figure 2.1: G-Tower

The 'A' here refer to the multi-faceted facilities of the building. It focuses on cost saving features such as constructed a Bridge Bar using recycled and recyclable materials. The G-Tower also focuses on the five-star services, high level of comfort, technology and advanced security system.

The first '+' of the rated grade shows that this building has obtained the Singapore's BCA's Green Mark GOLD recognition. G-Tower is designed to achieve energy and water efficiency. It consumes approximately 23% less energy compare to other buildings of similar size and location and uses water efficiency equipments and rainwater harvesting system in its daily water usage (G Tower, 2010). It also concern on the indoor environment quality. A system has been installed in the basement car parks to detect and monitor the level of carbon monoxide. The system will pump fresh air into the basement car parks once it has detected that the level of carbon monoxide has exceeded the its limit (Thean & Tee, 2010).

The second '+' implies that this building has achieved the Multimedia Super Corridor (MSC) Malaysia Cyber-centre status. The status was obtained on the 9th November 2009.

2.1.1 Malaysia's Green Building Index (GBI)

Malaysia's Green Building Index (GBI) was formed by the Pertubuhan Arkitek Malaysia (PAM) and the Association of Consulting Engineers Malaysia (ACEM). It was introduced on the 3rd January 2009 during the Green Design Forum organized by the PAM and was launched on April 2009 by the PAM and the ACEM. It was established to promote and to help the Malaysia property industry towards an environmental friendly industry. The GBI also intended to raise awareness about environmental issues especially to those involved in designing, constructing and operating a building. Those that involve are the designers, contractors, engineers, architects, planners, developers and also the public.

The rating system introduced in the GBI comprises of a complete framework to assess the environmental impact and the buildings' performance. By doing so, it will give the developers a good opportunity to design and construct buildings towards the green building concept. At the same time, it can also help to save the world by reducing the materials used and improve the surrounding environment. Buildings are evaluated and awarded the Malaysia's GBI rating based on the six criteria as follows: