PASSIVE DESIGN APPROACH TOWARDS ENERGY EFFICIENT BUILDING ENVELOPE FOR INDIVIDUAL RESIDENTIAL

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DEDICATION

To everyone,

To myself,

(As an architect in practice, pregnant lady and part time student)

To make it always seem possible until it is done.

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In the Name of Allah, the Beneficent, the Merciful

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ABSTRACT

Energy issues are very important nowadays, due to possibility of energy shortage in the future with the increasing population and living standards. The concern over the need to reduce energy consumption is growing that influenced awareness rapidly increases and it encourages the implementation of green building worldwide. This study focuses on pattern of passive design approach for building envelope in term of energy efficiency for individual residential. Individual residential especially bungalows were selected case study due to various approach of design philosophies for cooling factor in designing building envelope. In the reality, certainly undeniable that the practice on energy efficiency of building envelope design is crucial. Building envelope is a critical component of the building that serves as the outer shell or a protector to the user and building itself. This study describes an investigation of the effect of six passive design strategies on building envelope design, namely site planning and orientation, daylighting, façade design, strategic landscaping, renewable energy and natural ventilation. Calculation of Overall Thermal Transfer Value (OTTV) act as a tool to determine building envelope performance and it will identify whether the building fulfill the requirement of energy efficient or not. Based on the guideline in Malaysian Standard, Code of Practice on Energy Efficiency and Use of Renewable MS 1527(2007), OTTV of the selected building should be not exceed 50W/m2. In conclusion, this study outlines the preferred requirement of passive design approach for building envelope in term of energy efficiency for individual residential.

ABSTRAK

Isu-isu berkaitan tenaga menjadi penting dewasa ini disebabkan kebarangkalian akan wujudnya kekurangan tenaga di masa hadapan dengan populasi dan taraf hidup yang semakin meningkat. Keprihatinan akan keperluan untuk mengurangkan penggunaan tenaga semakin bertambah yang mempengaruhi peningkatan pantas akan kesedaran mengenainya dan ini menggalakkan perlaksanaan bangunan hijau di seluruh dunia. Fokus kajian ini adalah berkaitan corak pendekatan rekabentuk pasif bagi sampul bangunan yang menerapkan ciri-ciri kecekapan tenaga untuk bangunan kediaman individu. Bangunan kediaman individu terutamanya banglo dipilih sebagai kajian kes disebabkan kepelbagaian corak pendekatan bagi falsafah rekabentuk untuk faktor penyejukan bagi merekabentuk sampul bangunan. Pada dasarnya, tidaklah dapat dinafikan akan pentingnya amalan kecekapan tenaga bagi sampul bangunan. Sampul bangunan adalah komponen kritikal bagi sesebuah bangunan yang bertindak sebagai cangkerang luar ataupun pelindung kepada pengguna dan juga bangunan itu sendiri. Kajian ini akan menerangkan kesan bagi enam strategi rekabentuk pasif terhadap rekabentuk sampul bangunan. Ia melibatkan perancangan dan orientasi tapak, pencahayaan; rekabentuk fasad; perlandskapan strategik; tenaga boleh diperbaharui; dan pengudaraan semulajadi. Pengiraan ‘Overall Thermal Transfer Value (OTTV) bertindak sebagai satu alat untuk menentukan prestasi sampul bangunan dan ini dapat menegenalpasti sama ada bangunan tersebut memenuhi keperluan cekap tenaga ataupun tidak. Berdasarkan garis panduan yang ditetapkan oleh Malaysia Standard, Code of Practice oni Energy Efficiency and Use of Renewable (MS 1527(2007), OTTV bangunan yang dipilih tidak seharusnya melebihi 50W/m2. Sebagai kesimpulannya, kajian ini dapat menggariskan keperluan yang perlu dalam pendekatan rekabentuk pasif bagi kecekapan tenaga terhadap sampul bangunan untuk bangunan kediaman individu.

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LIST OF ABBREVIATIONS

AI	Average Index
CO2	Carbon Dioxide
EPS	Extruded Polystyrene
GBI	Green Building Index
GHG	Greenhouse Gas
MEDIS	Malaysia Energy Database and Information System
ITA	Investment Tax Allowance
IEA	International Energy Agency
KETTHA	Kementerian Tenaga, Teknologi Hijau dan Air
MMD	Malaysian Meteorological Department
MS	Malaysia Standard
NDP80	National Depletion Policy 1980
NEB	National Energy Balance
NEP79	National Energy Policy 1979
OTTV	Overall Transfer Thermal Value
PV	Photovoltaic
PDTfH	Passive Design Toolkits for Home
RES	Renewable Energy Sources
RETV	Residential Envelope Transmittance Value
SC	Shading Coefficient Factor
SPSS	Statistical Packages for Social Science
VAV	Variable Air Volume
VLT	Visible Light Transmission
WWR	Window Wall Ratio
α	Solar Azimuth
β	Solar Altitude

4FDP81	Four Fuel Diversification Policy 1981
5FP2000	Fifth Fuel Policy 2000

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Energy issues are becoming more and more important nowadays. There is possibility of energy shortage in the future with the increasing population and living standards (Yilmaz, 2007). The concern over the need to reduce energy consumption is growing and awareness rapidly increases, thus, it encourages the implementation of green building worldwide.

A green building is described as a building that is designed, constructed and operated to be resource efficient (Kubba, 2010; Wedding, 2008; Zigenfus, 2008). ASTM International defines sustainable or green building as a building that provides the specified building performance requirements while minimizing disturbance to and improving the functioning of local, regional, and global ecosystems both during and after its construction and specified service life. Therefore, energy efficient concept should be emphasized in order to achieve a green building. International Energy Agency (IEA) defines energy efficiency as a way of managing and restraining the growth in energy consumption. Something is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input (Yilmaz 2007).

Generally, the Earth is suffering global warming because of human activities affecting the environment. Climate change is caused by a number of things, and it will take an enormous amount of concerted efforts to fix it. Consequently, it involves thinkers, politicians, professionals and the public in resolving the associated problems. (Mir M. Ali, 2008). Besides, the current situation warrants vision, commitment, and action through partnership and commitment of governments, policy makers, experts, and the involvement of citizens. Therefore, the collaboration of urban planners, architects, engineers, politicians, academics, and community group is required. The energy shortage and global warming will be the legacy of the twenty-first century unless there is effort towards the notion and implementation of sustainability (Natee S. et al, 2014).

Sustainability was projected as an agenda to solve the global environment problems and to facilitate the economic. Sustainability can be seen as balance of social and economic activities and the environment (Bansal P, 2005) If examines more deeply, the key issues facing the building fraternity worldwide are buildings, energy and environmental (N.Al-Tarmimi and S.F.S.Fadzil, 2012).

In order to achieve energy-efficient concept, innovative ways to cut down energy consumption are necessary. To achieve the collective objectives of energy security and environmental protection, eco-sensitive buildings that utilize their resources judiciously, minimize their emissions and have efficient waste management systems, should be considered and designed (Surabhi C., 2008). On the other hand, International Energy Agency (IEA) reported electricity generation in 2006 was 96,000GWh, which represented an increase of 328% from 22,400GWh in 1990 (IEA, 2007). From the current trend of global energy consumption picturizes that there will be a significant increment in energy demand in the future. Meanwhile, record in 2008 shows that total energy consumption from all sources is 514 exajoules. It is explored that 80% from the total energy consumption in 2008 was generated from fossil fuels (BP, 2009). As addition, fossils fuels are finite resources and there is limited supply of them in the earth’s crust. As a non-renewable energy sources, formation of fossil fuels from the remains dead organism took over millions of years (Sharulnizam M., 2013). Hence, the limited reserves of fossil fuels cannot accommodate the high demand of energy in future.

Activity of burning fossil fuels to generate energy may cause imbalance of carbon cycle, which adds mammoth quantities of carbon to the environment. Human interference in the form of releasing massive quantities of Carbon Dioxide (CO2) into the Earth's atmosphere has already begun to disturb the equilibrium of the natural carbon cycle (Kluger, 2007) United Nation's (UN) Intergovernmental Panel on Climate Change had reported on February 2007, warming of the climate system is unequivocal and human activities have played a significant role by overloading the atmosphere with carbon dioxide. Hence, it will retain solar heat that would otherwise radiate away. Based on a research carried by UNEP's Sustainable Buildings and Climate Initiative (SBCI), it is discovered that the buildings' energy consumption leads to one third of global Greenhouse Gas (GHG) emissions.

Based on the data driven, Malaysia has a strong need for, and great potential to apply energy-efficient strategies in lowering energy consumption in buildings by reducing energy use for space cooling in buildings. It has been reported that more than 40% of the energy consumed by Malaysian buildings can be reduced if energy efficiency is practiced and sustainable technologies are applied to building envelope (Azni Zain, 2008). Building envelope systems are vital part of key component of residential buildings. The performance of the building envelope is influenced by various considerations, such as occupant comfort and productivity; energy use and running costs; strength; stability; durability; fire resistance; and aesthetic appeal of building (Chua and Chou, 2008).

1.2 Problem Statement

In the recent years, Malaysia is strongly maintaining high economic growth with the development of the economy. Therefore, its energy consumption has increase dramatically. Air conditioning for cooling accounts for more than 45% of the total electricity used in the residential sector (N.Al-Tamimi and S.F.S.Fadzil 2012). Due to current situation, the Malaysia government had been expressed interest in greater implementation of green buildings (Esa et al., 2011).

According to the Ninth Malaysia Plan, energy conservation culture must be inculcated. Buildings should be designed to optimize energy usage. Such resources need to be prudently and carefully utilized. The Malaysian government is adopting measures to reduce wastage by enhancing energy-efficient buildings and increasing energy sufficiency. On August 2009, the government had been launched the National Green Technology Policy by following the guideline (9^{th} Malaysia Plan, 2006). The objective of the policy is to provide direction towards the management of a sustainable environment. In addition, the Malaysian Standard (MS) 1525 (2007) which is the Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-residential Buildings was developed as a guide for energy efficient measures in Malaysia buildings. MS1525 emphasize that passive methods should be utilized before going to active methods. The basic approach towards good passive design is to orientate, to shade, to insulate, to ventilate and to daylight buildings.

In the reality, certainly undeniable that the practice on energy efficiency of building envelope design is crucial. Building envelope is a critical component of the building that serves as the outer shell or a protector to the user and building itself (A.Z.A.Halim and A.A.Halim, 2012). The needs of building envelope should be critically taken into consideration because it is involve the rate of excessive heat gain into the building.

There are few studies on building envelope in term of energy efficiency buildings and their thermal performance in Malaysia. Those studies were focused in non-residential buildings such as hotels, offices, etc. and few of those studies considered the residential factors. In the contrary, there is only limited amount of literature and research on energy-efficient individual residential building especially bungalow in in hot and humid climate.

The erection of individual bungalow should consider as energy efficient as possible. Naturally warm in winter and cool in summer. There are several advantages to living in an energy efficient home - saving money on energy costs is the most obvious (Surabhi C., 2008) Architects and designers accomplish the task through passive design, use of renewable energy technology systems, and/or natural building materials. Hence, preliminary study needs to be carried out to determine the current implementation of passive design approach of building envelope design. The comparison study on those design patterns on the selected individual residential should be conducted in order to propose the standard requirement of passive design approach for building envelope design in term of energy efficiency.

1.3 Research Aims and Objectives

The aim of this study is to discover the passive design approach for envelope building for individual residential in term of energy efficiency.

To attain this aim, the following objectives are pursued:

3.1 To determine the significant implementation of passive design approach of building envelope that considered Energy-Efficient concept.

3.2 To determine comparison between building envelope performance and difference factor adopt in passive design.

3.3 To propose the preferred requirement of passive design approach for building envelope in term of energy efficiency for individual residential.

1.4 Scope of Research

The scope of the research focuses on pattern of passive design approach for building envelope in term of energy efficiency for individual residential. Individual residential especially bungalows selected as potential case study due to various approach of design philosophies for cooling factor in designing building envelope.

This research describes an investigation of the effect of six passive design strategies on building envelope design, namely site planning and orientation; daylighting; façade design; strategic landscaping; renewable energy; and natural ventilation and also the four elements of building envelope design, namely wall; glazing (window); roof; and sun shading device. Calculation of Overall Thermal Transfer Value (OTTV) can determine whether the building fulfill the requirement of energy efficient or not. Base on the guideline in Malaysian Standard, Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-residential Buildings, 1527(2007), OTTV of the selected building should be not exceed 50W/m2.

1.5 Brief Research Methodology

At the first stage, preliminary research stage was done by reviewing literatures from journals, books and articles about related aspect of sustainable development, sustainable or green building, energy-efficiency concept, a study on MS 1525 (2007), Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-residential Buildings, passive design strategies, building envelope design and Overall Thermal Transfer Value (OTTV) to define and formulate conceptual framework of this study.

At the second stage, data collection stage that was involved several methodologies in getting reliable data for the research. Questionnaire survey forms were distributed among the consultant that involve in building construction industry such as architects, mechanical and electrical engineers, civil and structure engineers, quantity surveyors, clients and developers. In addition, record review of comparison study between building envelope performance and difference factor adopt in passive design on selected individual residential were conducted base in the resource and formula from MS 1525 (2007). Finally, all the significant data collection from questionnaire survey will be tabulated in verification checklist to be verified by the experts

At the final stage, in data analysis stage, all the data obtained was analyzed, follows by the discussion according to the aim and objectives of the research. Finally, conclusion was prepared to propose the preferred requirement of passive design approach for building envelope in term of energy efficiency for individual residential for future studies.

1.6 Expected Findings

Several anticipations are expected prior to the research and these can serve as a mean for better analysis of the outcome on the latter part.

i. The first expected findings touches on the common implementation of passive design approach of building envelope for individual residential. As there is only limited amount of literature and research on energy-efficient individual residential building especially bungalow in hot and humid climate, the researcher will provide the source of the literature for consideration of passive design approach towards energy efficiency of building envelope for individual residential.

ii. The second expected finding is to provide an understanding of relationship between the differences factors adopt in passive design with the building envelope performance base on calculation of Overall Thermal Transfer Value (OTTV). The construction practitioners will take a necessary countermeasure in designing their building envelope with the passive design approach to create a building that consumes a less energy.

iii. The last expected findings will disclose the significance of energy efficiency concept in building envelope design. Hence, the researcher is able to reduce appropriate passive design approach for building envelope in term of energy efficiency concept. Therefore, preferred requirement of passive design approach is proposed to serve as a guide for future consideration of building envelope design for individual residential.

1.7 Significant of Research

The research effort emphasizes to the literature of construction/project management in several ways:

i. The results of this study will become a source for construction practitioners within the Malaysian construction industry to consider the passive design approach towards energy efficient of building envelope for individual residential in Malaysia.

ii. The study is expected to provide new insights in which of adoption of green design for building envelope for individual residential in Malaysia

iii. This study will also provide the preferred requirement passive design approach for building envelope design for individual residential in Malaysia.

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