CLIMATIC RESPONSES ON THERMAL DESIGN OF BUILDINGS FOR ENERGY EFFICIENCY: COMPARATIVE STUDY FOR TAMAN NEGARA PAHANG AND OTHER MICROCLIMATES

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2. Letter of Offer (Research Grant)

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Tuan/Puan

TAJUK PROJEK FRGS TAMAN NEGARA : CLIMATIC RESPONSES ON THERMAL DESIGN OF BUILDINGS FOR ENERGY EFFICIENCY AND SUSTAINABLE BUILT ENVIRONMENT

Dengan hormatnya perkara di atas adalah dirujuk.

Dimaklumkan dalam Mesyuarat Penilaian Projek Penyelidikan FRGS yang telah diadakan pada 8 Mac 2007, telah meluluskan projek penyelidikan seperti tersebut diatas dengan syarat-syarat berikut:-

i. Projek ini bermula pada 1 Mac 2007.

ii. Kos yang diluluskan ialah sebayak RM50,000.00 dan perbelanjaan hendaklah mengikut butiran bajet yang telah ditetapkan. Sila buat pindaan di dalam bahagian belanjaan dan kembalikan ke IRDC.

iii. Semua pembelian bahan/peralatan adalah diminta agar tuan/puan mematuhi prosedur perbendaharaan di mana pembelian melebihi RM500.00 hendaklah mengemukakan sebutharga.

iv. Tuan/puan dikehendaki mengemukakan laporan prestasi secara ringkas 2 kali setahun dan juga laporan prestasi projek tahunan secara terperinci dengan menggunakan format yang ditetapkan.

v. Tuan/puan dikehendaki mengemukakan laporan prestasi kewangan tahunan secara terperinci dengan menggunakan format yang ditetapkan.

vi. Laporan Akhir mesti dihantar dalam tempoh 3 bulan selepas projek penyelidikan disiapkan dengan menggunakan format yang ditetapkan dan hantar ke IRDC sebanyak 2 naskah dan 1 'softcopy' dalam bentuk CD.

PENYELIDIKAN, PEMBANGUNAN DAN PENGKOMERSILAN LANDASAN KEWIBAWAAN DAN KECEMERLANGAN

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Ketua Perundingan : 03-55442100
Ketua Pengkomersilan : 03-55442750
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5. Report

5.1 Proposed Executive Summary

The alarm about global warming has galvanised the international community towards formulating global agreements to address the emerging related issues on humankind and environment (United-Nations, 2006a, 2006b, 2004). In the aspiration for Vision 2020, the Government of Malaysia has included sustainable development as one of the development thrusts in the 8th and 9th Malaysian Plan. In the area of built environment, sustainable development includes energy resources and the efficient usage that have various short-term and long term impacts on the environments and thus the humankind.

Renewable energy is in the limelight for the provision of sustainable energy resources. The Suria 1000 programme project under the *Malaysian Building Integrated Photovoltaic* (MBiPV) project demonstrates an incentive for the involvement of building sector in the solar energy industry (Malaysia, 2004). *Energy Efficiency* (EE) in building is influenced by the architectural design, building services, and also the users' behaviour (Baker and Steemer, 2000) in proportion of 25 %, 25 %, and 50 % respectively (Australia, 2003). Among these, building design has the most enduring effect, and energy assessment in building could commence as early as the pre-design stage via appropriate simulation modelling tools as well as after completion of the construction by means of energy auditing. *Thermal design* of building can be defined as *a technical design technique for the construction of the envelopes to act as an efficient thermal barrier between the indoor and the outdoor conditions.* It controls the indoor climate by the thermal characteristics of the material and construction of the envelope.

This project is to investigate the climatic responses on the thermal design of buildings in Malaysia to achieve sustainability in the sector of built environment. These will be evaluated by analysing data collected via physical monitoring and computer simulation. The outcome is to contribute to contribute to recommendations and guidelines on climatic thermal design for sustainable built environment. The objectives are:

1. To investigate the climatic responses on the building thermal design via physical monitoring
2. To investigate the climatic responses on the building thermal design via computer simulations
3. To identify building thermal design strategies for energy efficiency and sustainable built environment

5.2 Enhanced Executive Summary

The objectives of this study are to investigate the climatic responses via physical monitoring and computer simulations for Taman Negara Pahang and other microclimates, and finally to identify building thermal design strategies for optimum thermal energy performance in the tropical climate of Malaysia. It was conducted in two phases. Phase 1 evaluated the thermal performance via physical data monitoring. Data were analysed for the thermal impact due to microclimate and building materials. Eleven naturally ventilated low-rise residential buildings in three microclimates of urban, rural and tropical rainforest were used as case studies. The building selections were based on the type, configuration, and thermal design. The selections are: six double-storey linked heavyweight in an urban area; one double-storey detached mix-weight in a rural area, one single-storey detached heavyweight and one single-storey detached lightweight; and lastly, one single-storey link heavyweight and one single-storey detached lightweight in tropical rainforest of Taman Negara Pahang. Data were simultaneously and consecutively logged using automated data logger systems for a period of two to four weeks. The thermal impact was appraised by the indoor and outdoor temperatures, relative humidity, temperature difference, thermal capacity, thermal diffusivity, and decrement factor. In Phase 2, a building thermal energy simulation software was used to evaluate the impact of building material on the cooling load. A conventional single-storey residential building with lightweight and heavyweight materials were simulated in three neighbouring tropical climatic regions; Subang, Singapore and Kuching. The findings conclude the followings: the outdoor and indoor temperature is highest in urban microclimate and the relative humidity in rainforest is consistently the highest all the time; the overall temperature variation due to microclimate varies from about 3 °C to 6 °C; heavyweight construction is more advantageous than lightweight during daytime and the reverse is true at night-time; hence, a mix-weight construction is most suitable for a double-storey residential dwelling; due to temporal thermal impact of the construction material, heavyweight construction leads to cooling load savings of up to 3.2 % for daytime cooling but imposes a penalty of up to 7.6 % for night-time cooling.

5.3 Introduction

The world climate is generally categorised into three main types based on Köppen classification, namely tropical, temperate, and cold, and are further subdivided with other locality specifications. Climate is characterised and determined by spatial and temporal atmospheric variations and are termed as: global climate that refers to the planet earth as a whole, macroclimate or regional climate as a condition for a region such as a state or a country on a scale up to 1000 km horizontally and 10