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Thermal Comfort of Residential Building in Malaysia at Different Micro-Climates

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Abstract

This study examines the level of the thermal environment in residential building in Malaysia at various urban micro-climates which are Kuala Lumpur (KL), Bayan Lepas (BL) and Kuching (K). A simulation model of a typically-designed residential building in Malaysia was constructed to determine the indoor temperatures in the indoor living spaces, namely living cum dining area (DL), wet kitchen (K) and master bedroom (MB). Findings suggest that the highest indoor temperature of 32.6 °C was obtained in a master bedroom (MB) in under KL climate at 1400 hours. Overall, indoor temperatures are higher than the indoor design conditions recommended in Malaysian Standard; MS1525:2007.

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Keywords: Thermal discomfort; indoor temperature; Ecotect; Meteonorm

1. Introduction

Indoor thermal environment is part of the indoor environmental quality component that close influence by the climatic condition. Nowadays, the climate change phenomenon has caused a threat to the human environment. Occupants' behavior and activities relatively contribute to the effect of global warming, as a result, of building energy consumption and carbon emission (Ismail, Abdul Samad, Rahman, & Yeok, 2012). Malaysia is located near to the equator experience the warm and humid climate condition. The

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most crucial climatic impact in Malaysia buildings are high intensity of solar radiation and high daily air temperature (Al-Tamimi & Syed Fadzil, 2011, Sadafi, Salleh, Chin, & Jaafar, 2011). Other than these climatic elements, a little wind movement and higher relative humidity has greatly affect occupants' indoor thermal comfort in buildings. Due to excessive heat and high air temperature, building designers prefer to adopt mechanical system in building design such as air-conditioning in achieving required indoor thermal comfort which resulting in increased energy consumption in building (Hien, Poh, & Feriadi, 2000, Kubota, Jeong, Toe, & Ossen, 2011 and Zr & Mochtar, 2013). This study attempts to identify the level of indoor thermal environment and indoor living spaces in a typically-designed residential building model in urban areas of Malaysia. A simulation of the hourly weather data in existing residential building design was carried out to analyse the indoor air temperatures. Hence, the finding addresses the issues of thermal discomfort condition in residential building at different urban micro-climates and indoor living spaces in Malaysia.

2. Literature Review

A building in tropics means a confrontation of construction and function with intense climatic condition. Tropical climate regions characterized as high humidity, excessive rainfall and considerable sunshine. Typical features of tropical climate have the negative impact and positive impact to the building design. The extreme impacts caused by the tropical climate through its climatic parameters such as temperature, solar radiation, relative humidity, rainfall and wind. It is ideal medium state for rich of tropical plants and rainforest. A successful indoor environment much depends on an understanding of the environmental factors, including building design and setting. Healthy and comfortable indoor environment have become important in sustainable built environment. Major factors determining the ecosystems that develop, but within any ecosystem itself comprise complex interactions and minor variations that result in smaller communities within which call as a micro climate (Yeang, 2006). The microclimate around the building, establishing through the interaction with other buildings or the natural environment, is a significant factor in the building energy consumption and indoor building environments.

2.1. Malaysia climatic condition

Malaysia is a tropical country characterized as warm and humid located within the Tropic of Cancer and Capricorn. The latitude of 1° - 7°N and longitude 100° - 119°E. The climatic elements categorized as high temperature and uniform diurnal pattern throughout the year. The annual mean temperature is 26.4°C with average daily maximum temperature is 34°C and average daily minimum at 23°C (Al-Tamimi & Syed Fadzil, 2011). The annual relative humidity value ranges within 74% to 86%. Malaysia has a complete, clear sky in the day for the whole year, ranging from 3.7 hours to 8.7 hours per day. On the average, sunshine receives about six hours a day ("http://www.met.gov.my," 2012). Malaysia also experiences high solar intensity and duration. Weather data analysis in term of building design for warm-humid climate is overheating is not as great as in hot–dry areas but it is aggravated by high humidity and small diurnal temperature variation (Haase & Amato, 2009). There are two main factors; high air temperature and relative humidity affects comfort and health of occupants living inside building without good ventilation system (Sookchaiya, Monyakul, & Thepa, 2010). As a consequence, the changes of heat balance in the environment will increase air temperature especially in built-up urban areas compared to suburban or rural areas (Priyadarsini, Hien, & Wai David, 2008). The inverse relationship between forest cover and built-up area in affecting land surface temperature shows the importance of vegetation coverage in minimising the thermal energy response in urban areas. However, building form, site plan and road layout in most new housing development area have been unconsidered strongly a hot, humid