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# Effective solar chimney cross section ventilation performance in Malaysia terraced house

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**Abstract**

In hot and humid country, ventilation and thermal performance could be improved by effective natural ventilation strategies. However, the climatic conditions of the tropical countries are mainly distinguished by high air temperature and relative humidity as well as low wind velocity which are the main factors that reduce the comfort level of occupants, especially in the terrace house. The use of solar chimney in terrace house is one of alternatives to increase the thermal and ventilation performance of the indoor environment. This study initiated with field measurement in a selected case study house located in Kuching, Sarawak, Malaysia for software validation. Validation study of CFD in DesignBuilder software was done by compared with field measurement data, with the deviation ranges from 7.2% to 18%. The optimizations of solar chimney cross section were carried out. The results of CFD were observed in order to study the optimized length and width gap of solar chimney that could induce optimum air velocity and thermal performance in the indoor environment. The results show that the effective width gap for 36m³ room ranged from 0.6m to 1.0m while the length from 1.5m to 2.0m, whereby the induced air speed ranged from 0.04m/s to 0.223m/s. Based on the findings, the study has shown that the effective gap and length of solar chimney could increase the air velocity of indoor environment that creates a cooling effect on human body, especially for terrace house in Malaysia climate.


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*Keywords:* solar chimney; natural ventilation; thermal performance; CFD simulation

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## 1. Introduction

Occupied spaces in buildings need fresh air for ventilation in order to eliminate the air pollutants. There are two types of ventilation, where the fresh air could be supplied either via mechanical ventilation systems or natural ventilation strategies. Recent years, the latter strategy has become the highlight in the building industry, where most of the developers and designers have switched their direction on architectural perspective towards building performance as well as appreciation towards the environmental factors, such as daylighting and natural ventilation.(Jörn von Grabea et al., 2014) One of the reasons could be stated by the fact that the application of passive strategies in architecture could reduce carbon footprint and to reduce the urban heat island, as well as the release of carbon dioxide to the environment.

The literature stated above have researched on varies of design and configuration of solar chimney in order to refine the function. Therefore, this study is intended to investigate the influence and effectiveness of the solar chimney on thermal performance of existing terrace house without solar chimney in hot and humid climate via application of CFD simulation. In order to investigate the effectiveness of the solar chimney to the existing house, two objectives have been figured out as follows:

- To investigate the thermal performance of the bedroom in existing terrace house under hot and humid climate.
- To scrutinize the effect of introducing solar chimney on the indoor thermal performance.

The field measurement was carried out in a selected single storey terraced house, and the collected data was input into the computer simulation software as boundary condition. The CFD simulation software - 'DesignBuilder' was applied to carry out the modelling and simulation tasks in this study. The validation of the software was carried out by comparing the field measurement result and the simulation result.

### *1.1. Local climate condition*

The case study single storey terraced house is located at Kuching, Sarawak, East Malaysia. Kuching is the capital city of Sarawak state, which is the largest state in Malaysia. Since the topography location of Malaysia is close to the equator, the hot and humid climate is emphasized with the frequent and heavy rainfall as well as long hour of solar irradiance. The yearly average air temperature falls between 32.2°C to 33.89°C while the relative humidity ranged from 57% to 100% throughout the year. The hottest season of the year lasts from early April to end of June with daily maximum temperature above 31.67°C while the coldest season of the year lasts from early December to early of February with minimum air temperature of 22.78°C. Kuching received shortest hour of daylight during 21 December and longest hour of daylight at 20 June, which are 12:03 hours and 12:13 hours respectively. In average, Kuching receives only 5 hour of sunshine per day. The wettest times of Kuching are during the North-East Monsoon season, which is started from November to February and the dry season starts from June till August. The rainfall distribution recorded from 185.6mm to 4116.7mm throughout the year. In general, Kuching experiences constant high air temperature and high relative humidity throughout the year accompanied by heavy rainfall as well as low wind velocity.

### *1.2. Thermal comfort studies in Malaysia*

Thermal sensation of the occupants is influenced by the environmental aspects, which are air temperature, relative humidity, mean radiant temperature, air velocity, clothing as well as activity done by occupants (P.O.Fanger, 1970). Amounts of literatures about thermal comfort has been published and proposed by researchers. Producing a standard and universal assessing thermal comfort index to fit some or all of the regulating factors into single index was major concerns of researchers. (Sadafi et al., 2011). In this paper, the thermal comfort determined by air velocity and air temperature, which is indicated at Table 1. Since Malaysia experienced high air temperature that determined the discomfort level, the minimum target thermal comfortair temperature of 29°C and ideal indoor air velocity is 1m/s.