CHAPTER 3

Louvres Geometry of Window on Natural Ventilation in Residential Building With Solar Chimney

Pau Chung Leng, Gabriel Hoh Teck Ling, Mohd Hamdan Ahmad, and Dilshan Remaz Ossen

3.1 INTRODUCTION

The design of passive homes is driven by five principles: airtightness, thermal bridge-free design, thermal insulation, passive house windows and ventilation. Natural ventilation is one of the popular passive cooling methods used in domestic buildings. It increases the thermal efficiency of a building by improving the comfort zone of the occupants (Cheng et al., 2016; Costanzo & Donn, 2017). In compared to mechanical ventilation, it is the most energy-efficient strategy for controlling indoor air quality, approximately 40 percent from the total cost spent (Alloca et al., 2003). Furthermore, it may be utilised as a passive cooling strategy to minimise building cooling demand.

Natural ventilation is easily applicable in hot, dry areas, but in hot humid climates, it is often challenging to achieve the thermal comfort. Hence, according to Olgay bioclimatic chart, the thermal comfort analysis tool that connecting air temperature, relative humidity and wind flow, the effect of wind speed reduces the thermal discomfort caused by high air temperature. As stated by Givoni, Olgay has recommended that for every 0.275 m/s increase in air speed, the upper temperature limit rises by 1 °C to 28 °C, which is the maximum interior air speed permitted (Givoni, 1992).

Thermal performance of building is one of the important criteria in the domestic living environment. Indoor thermal environment is one of the consequential components of indoor environmental quality that is greatly influenced by climatic conditions. The utilization of natural ventilation commonly applied to maintain comfortable indoor thermal environment and to remove the air pollutants. While it is also a passive cooling approach, it may minimise the cooling load of buildings. For solar energy control, the skin and fenestration of the building usually play an important role as a filter between the outdoor conditions and those inside the building.

Human behaviour and habits have a significant impact on the effects of climate change. A mechanical ventilation system such as air-conditioning is preferred in the building design because of the high air temperature and excessive heat gain in tropical climate (Hien et al., 2000; Jamaludin et al., 2015; Zr & Mochtar, 2013). This results in a rise in energy consumption in the building, which is not desirable in the living environment.

Hence, in order to reduce the energy consumption and carbon footprint to the environment while maintaining the thermal performance of the building, increasing the air flow in the indoor environment via natural ventilation is the key to promote the thermal comfort. Out of various approaches to induce the natural ventilation, exploration of the configurations of window (inlet of air flow) possesses the high potential with reasonable cost. This study explores the potential of louvres window in residential building to induce air flow speed (natural ventilation) via the simulation.

3.2 CLIMATIC CONDITION IN MALAYSIA CONTEXT

Malaysia is a tropical nation with warm and humid weather between the Tropics of Cancer and Capricorn. The latitude ranging from 1° to 7° North and the longitude ranging from 100° to 119° East. Malaysia, like other Southeast Asian nations with a tropical climate, has high temperatures and high humidity levels all year round due to its proximity to the equator. Since Malaysia's geographical structure is encompassed by seas and exposed to high levels of humidity due to its vicinity to the equator, the country experiences hot and humid climates. The high humidity levels increased the air temperatures generated by intense sun radiation, which evaporates the waterbody and sea. In Malaysia climate condition, the nocturnal and diurnal air temperatures range from 21 °C to 32 °C, with an annual average temperature of 26.4 °C as well as mean daily minimum and maximum temperatures of 23 °C and 34 °C respectively (Al-Tamimi et al., 2011; Malaysia, 2018). During the summer solstice, when the day lasts longer than the night, places near the tropics (Tropics of Cancer & Capricorn) will have 5 - 7 kWh/m^2, whereas during the winter solstice, it will have 1.5 - 3 kW/m^2.

On average, Malaysia receives about 4.96 kWh/m^2 of solar radiation in a year. The Northern region of Peninsular Malaysia and the Southern region of East Malaysia receive the highest solar radiation, with 5.56 kWh/m^2. Peninsular Malaysia's southern and north eastern regions, as well as the major regions of Sabah, receive the least amount of sun radiation (Azhari et al., 2008).