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STUDY ON THE OPTIMUM ROOF TYPE WITH 30° ROOF ANGLE TO ENHANCE NATURAL VENTILATION AND AIR CIRCULATION OF A PASSIVE DESIGN

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ABSTRACT

One of the major problems in modern housing design is overheating. Occupants suffer higher indoor temperatures due to a lack of natural ventilation. This issue arises because of poor passive design. A good passive design promotes natural ventilation and provides better indoor air temperatures without reliance on mechanical cooling systems. The roofing system plays an important role in a house's design. Since the roof contributes to 70% of the total heat gain, it is important to investigate its design to reduce the impact of overheating. It has been found that many roofs lack a ventilation system in the top part of the house. These openings in the roof provide areas for trapped hot air to exit into the environment. The openings also enhance natural ventilation and allow for effective air circulation inside the house. The optimum roof is designed to tackle this matter by reducing the overheating inside the house, especially during the hottest hours of the day. The hot air exits based on the differences in air density and due to prevailing wind. In this study, the optimum roof was tested on a small-scale model and verified by simulation using computational fluid dynamic (CFD) software, namely ANSYS 18.0. From the data obtained, it was proven that the opening in the roof reduced the indoor temperature. In conclusion, the optimum roof could improve the passive design and help to reduce overheating inside a house.

Keywords: Computational fluid dynamic simulation; Heat transfer; Optimum roof; Ventilated roof

1. INTRODUCTION

Malaysia is located in the equatorial region and experiences high temperatures with high relative humidity throughout the year. The average solar radiation in this hot, humid climate is between 4.21 kWh/m^2 and 5.56 kWh/m^2, annually (Azhari et al., 2008). Malaysia receives 8.7 hours of sunlight per day (Malaysia Meteorological Department, 2014). The recommended thermal comfort level ranges from 25 to 28°C (Ibrahim, 2004). Based on a previous study on concrete terrace houses in Malaysia, indoor temperatures are only comfortable to the occupants for a few hours every day (Ibrahim et al., 2014a). The same study also discovered that the indoor temperature could reach more than 30°C during the daytime. Increased indoor temperatures in a building are due to poor passive design. Designers should adapt more natural

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