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Assessment of Passive Thermal Performance for a Penang Heritage Shop house

N.A.M. Omar*, S.F. Syed-Fadzil

School of Housing, Building and Planning, Universiti Sains Malaysia, 11800 USM, Pulau Pinang, MALAYSIA.

Abstract

In recent years, Malaysia has seen an increase in energy consumption by buildings from all sectors. A significant portion of the energy consumed annually is spent to cool residential and commercial buildings. However, there is possibility that the country's overall energy usage may be reduced, provided that steps are taken to minimize cooling loads in buildings via passive means. Considering Malaysia to be a country of hot-humid climate, many modern building designs have been observed to ignore the general characteristics of the region's vernacular architecture. These are the key elements which help to reduce solar heat gains during the day. Properly conserved heritage buildings however, are seen to possess some of these qualities which may allow them to remain cooler than their modern counterparts under similar conditions. This paper discusses the thermal performance of a heritage shop house in Penang, Malaysia, which uses passive cooling. Aspects which are looked at are the overall design of the buildings as well as recorded thermal data collected during a pilot study. The results show that the building provided an indoor environment that is cooler than the outside. Suggestions are also made to further improve the indoor thermal environment.

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* Corresponding author. Tel.: +6 012 433 22 31
E-mail address: namo10_hbp004h@student.usm.my

1. Introduction

In the year 2010, Malaysia has seen an increase in energy dependency, particularly in the residential and commercial sectors. Together, these two building categories consumed more than half of the country's generated energy [1]. From this amount, the air conditioning facility in a typical household consumes approximately 21% of energy use, while electric fans use about 2% [2]. Taking into consideration the significant amount of electricity spent on cooling devices, it is possible that by reducing cooling loads in buildings via passive means, overall energy use in these sectors may be lowered as well.

One such building which belongs in the residential and/or commercial sector is the 'shophouse'. In Malaysia, it is relatively common to find shophouses, especially in the state of Penang. There are around 7000 units in this state alone [3]. Many of Penang's shophouses were built in the 19th and 20th century, corresponding with the arrival of tradesmen from Southern China [4].

On the 7th of July 2008, the city of George Town in the state of Penang, Malaysia was inscribed as a World Heritage Site by UNESCO. According to the 'outstanding universal values' (OUV) assessment, it is said that George Town represented a 'Melting Pot of Multicultural Architecture and Townscape' [5]. This reinforces Penang's status as a world-recognized place showcasing a distinct blend of influences which resulted in a large variety of architecture such as townhouses, religious buildings of different faiths, colonial public buildings and also shophouses. With the inscription also came the responsibility to conserve these centuries-old buildings, located within the heritage site of George Town.

The heritage shophouses in Penang can be categorized either in the Early 'Penang' Style (1790s - 1850s), 'Southern Chinese' Eclectic Style (1840s - 1900s), Early 'Straits' Eclectic Style (1890s - 1910s), Late 'Straits' Eclectic Style (1910s -1940s), Art Deco Style (1930s -1960s) or Early Modernism Style (1950s -1970s). These buildings typically stand at two storeys high. The lower floor serves as commercial space for trading whereas the upper floor usually serves as the tenants' residence. Shophouses were built in rows, which formed the streets and town grid. Typical building materials found in these buildings are clay bricks, granite, plaster and timber.

The original design of the Penang heritage shophouses is suggested to be influenced not only by the prevalent colonial and Chinese influence of the time, but also the hot and humid character of Penang's local climate [6]. Therefore, as well as having key design elements such as arches and stylized columns, most of the original shophouses have large openings, louvered doors and sheltered pedestrian walkways (also called five foot-way); all part of an integrated design which responds to the need of solar shading and passive cooling. Other features such as jack-roofs and air wells can also be found in some of the buildings.

Considering the increasingly pressing issues of energy use, environmental sustainability and also the implication that a large number of shophouses will continue to exist for many years under the protection of World Heritage Site, UNESCO, it is important for the environmental impact of these buildings to be discussed. Information of various types have resurfaced since the World Heritage Site inscription such as building catalogues and drawings, but little has been researched in regards to the claims of heritage shophouses operating on low energy and having climate-responsive characteristics [6, 7, 8].

This paper discusses the thermal performance of a heritage shophouse in Penang, Malaysia, which uses passive cooling. Unlike contemporary buildings of the same type, the heritage shophouse possesses various architectural features which would theoretically allow it to keep cool during the day. Aspects which are looked at are the overall design of the buildings as well as thermal data collected during a pilot study. The results show that the building provided an indoor environment which is cooler than the outside. Suggestions are also made to further improve the indoor thermal environment.

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