UNIVERSITI TEKNOLOGI MARA

BALCONY VENTILATION: UTILISING WING WALL TO ENHANCE NATURAL VENTILATION OF DOUBLE-STOREY TERRACE HOUSE IN MALAYSIA

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ABSTRACT

For generations, natural ventilation is the most efficient passive strategy for regulating the indoor temperature, hence providing healthy indoor environment. However, in contemporary architecture, natural ventilation is not being exploited to its maximum potential, particularly in landed houses. The efficacy of natural ventilation can be affected by a number of factors, especially façade treatments such as balconies. As balconies have been extensively introduced into dwellings for a variety of functions, nevertheless, the provision of a balcony as a passive design solution to improve natural ventilation is not among them. Moreover, a building with a deep layout plan such as terrace houses, in particular, a single-sided ventilation strategy is inevitable, resulting in a substantially reduced ventilation efficiency compared to a cross-ventilation strategy. Consequently, the performance of balcony ventilation can be significantly improved by incorporating wing walls into balcony design, since wing walls are an effective facade treatment for increasing the ventilation flow rate of single-sided openings. This study therefore aims to propose wing wall for balconies to improve natural ventilation performance of double-storey terrace houses in Malaysia. Hence, there are three objectives that were addressed in this study. The first objective is to investigate the wing wall configurations that enhance the balcony ventilation in terrace houses. This was achieved through a rigorous searching effort via Systematic Literature Review (SLR) in identifying the pertinent publications that studies on the impact of balcony design and its integration with wing walls. SLR were then followed by identifying balcony design that perceives unsteady airflow performance through structured observation on the existing balconies of double-storey terrace houses within Taman Cheng Setia, Malacca. This method was executed in order to achieve the second objective which is, to identify the existing balcony design of double-story terrace houses that may experience unstable natural ventilation performance. Hence, open balcony that received parallel wind were established as a balcony that perceived to experience unstable natural ventilation. The third objective which is to determine the performance of various wing wall configurations in order to recommend the optimum configurations in improving natural ventilation. The methodology employed was a computational fluid dynamics (CFD) software that was validated using existing fieldwork measurement data from a selected case study. The final CFD simulation was conducted on a simplified model of a double-storey terrace house with a balcony connecting to the master bedroom where four wing wall depths and wing wall angles on two different locations were applied to the balcony. Analysis on the predicted CFD models shows that with an appropriate configuration, utilising wing wall in balcony design could enhance the indoor air velocity as well as improve the airflow distribution within the room. Internal airflow distribution was enhanced by increasing wing wall depth to a maximum of 2.20 metres and deviation of 22.5°. This research therefore able to establish where the provision of wing wall in balcony is a feasible facade design method for improving indoor ventilation and significantly reducing energy consumption in buildings. Future innovations in balcony design utilizing wing walls could offer significant advantages for consumers, promoting towards healthy living and energy efficient dwellings.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Sustainability has been the phrase chosen to act as a bridge between development and environmental protection, in which it is commonly perceived as the practices and activities by which civilization minimises the loss of natural resources in an attempt to maintain an ecological equilibrium that does not enable the life expectancy in societies to deteriorate (Rogers et al., 2007). The perspectives on sustainability appear to be more concentrated with the present and maintaining a specific measure. Moreover, the term "sustainability" were traditionally derived from the Latin word, “sustinare”, which combines the words "sub", meaning "from below," and “tenare”, which means "held up," to convey the concept of something which endorses, retains, or sustains over time (Martek et al., 2018). Generally speaking, the primary objective of sustainable construction would be to transition from environmentally unfriendly to environmentally friendly technology and materials in building construction (Neyestani, 2017). Moreover, terms like "sustainable development" and "sustainable lifestyle" are already so ubiquitous in a colloquial speech that it is absurd to think that the notion had been relatively nonexistent until the 1980s. The topic of sustainability, however, has seen an emergence in awareness since the beginning of this century, with just a Google search for the term yielding more than 100 million results today. Despite the fact that the term is relatively new, the significance of "sustainability" has evolved immensely.

In the 1987 Brundtland Report of the United Nations' World Commission on Environment and Development, the notion of "sustainability" was initially defined as a growth that satisfies the needs of the world today without jeopardising the capability of coming generations to accommodate their own necessities. Interpretation of sustainability customarily originates, as previously indicated in earlier publications by prior researchers, is that sustainable development has now become development which fulfills the demands of today yet without jeopardising the needs of present and future generation after generation (Borowy, 2013). A further crucial aspect of sustainability is