UNIVERSITI TEKNOLOGI MARA

APPLICATION OF A FIBONACCI SEQUENCE-DERIVED WIND-CATCHER SCOOP LOUVRE GEOMETRY FOR NATURAL VENTILATION IMPROVEMENT

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ABSTRACT

A wind-catcher is a passive strategy to achieve thermal comfort in a building. It helps in the modification of indoor temperature by capturing and channeling outdoor wind flow into the interior space. The rate of fresh air that could be conveyed into a building is a key parameter that determines the performance of a wind-catcher. Fibonacci sequence is a recursive sequence, generated mathematically by adding two previous numbers in the sequence. Its sequence is rhythmic to the natural flow, and as such its application can result in the improvement of effectiveness of aerodynamic-dependent products. Examples of contemporary applications are the design of fans, propellers, impellers, and aerators of PAX Scientific Company, established in United States (USA). This study examined how Fibonacci sequence is applied to improve the efficiency of a particular wind-catcher model. It focused on applying Fibonacci sequence principle to formulate the geometry of the louvres of the scoop of a wind-catcher system. The study was driven by the same line of inquiry proposed by Jay Harman – "If fluids always tend to follow a particular path, is there a way to design equipment that takes advantage of this fact?" The dissertation began with a presentation on the background and current understanding of wind-catcher and Fibonacci sequencing principles. Computational Fluids Dynamics (CFD) simulation instrument was used to test and analyze the performance of one particular wind-catcher model. The performance was measured based on the volumetric airflow where the proposed louvre pattern was compared to a conventional design. The results showed an improvement in the performance of the system by 11%. Further simulation runs were then performed to determine the optimum number of louvres to achieve maximum performance. The results revealed that the wind-catcher with two louvres is optimum. How these values impact the thermal comfort condition of the interior was later investigated using IES software. The results revealed that the increase of wind velocity contribute slightly towards the improvement of the thermal comfort performance of the whole system

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1.1 INTRODUCTION

The revival of the interest towards natural ventilation strategies in buildings is the result of rapid pace of growth in population and construction, cumulative consumption of energy and a desire to tackle against global concerns of human settlements in terms of cost, social and environmental threats (Allard, 1998). Buildings are at the core of this issue; based on the examinations of CIBSE (Chartered Institute of Building services Engineers), within the European Union, for example, about 160 million buildings consume 40% of energy simultaneously produce over 40% of Carbon Dioxide (CO2) emissions.

Li & Mak (2007) noted that natural ventilation is increasingly being used in modern buildings to control the utilization of non-renewable energy and the credence on mechanical ventilation means. Zarandi (2006) declared that a building should be designed in agreement with its orientation. The principles of designing rely on the fact that a building or a structure is a tiny part of our surrounding nature; it must act as a part of eco-system and placed into the life-cycle of organism. Based on it, the design of passive-energy strategies, such as a wind-catcher, is a great achievement to find a harmony between human settlements and the nature.

Young (1989) stated that architectural elements found in vernacular architecture such as a wind-catcher should be modified, adopted, evaluated and developed to fit modern requirements. A wind-catcher captures and channels outdoor air into a building to enhance the rate of ventilation.

This study examined how Fibonacci sequence was applied to improve the efficiency of a particular wind-catcher model. It focused on applying Fibonacci sequence principles to formulate the geometry of the louvres of the scoop of a wind-catcher.