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Opening Performance Simulation in Natural Ventilation using Design Builder (Case Study: A Residential Home in Rasht)

Abdollah Baghaei Daemci^{a*}, Armita Khalatbari Limaki^a, Hossein Safari^a

^a*Department of Architecture, College of Architecture, Islamic Azad University Branch of Rasht, Iran*

Abstract

Wind is known as one of the most mature renewable energies which reduces cooling energy in buildings and improves indoor air quality. Natural ventilation is one of solutions to prevent humidity disposal from the interior of the home. The shape and pattern of the air flow inside a room are influenced by two factors: the wind and the pressure difference caused by the temperature difference. Wind is taken into account in this study. Natural ventilation was studied using computerized simulation and the comparison of results in two sections. In the first section, bilateral ventilation simulation was performed in a residential apartment complex. In the second section, one-way ventilation was studied in the bedroom. The results indicate that both simulations require a driving force, which is wind, in order to have optimal mode and maximum wind circulation in the interior space. This wind can be supplied by architectural elements. Given that natural ventilation has not been much taken into account in recent years in Iran and no design guideline has been taken into account for engineers in this regard, such studies can help designers to understand renewable energies. This would help informed designing based on clean energies in order to reach better ventilation. In this regard, wind simulation was performed using CFD model by Design Builder Version 4.5.

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1. Introduction

In order to manage and reduce greenhouse gas emissions, the current global trend has moved towards the use of clean energy technologies such as wind and solar energy (photovoltaic) [1]. Scientists around the world have

* Corresponding author. Tel.: +98-9385051886.

E-mail address: Baghaei.public@yahoo.com, Baghaei@iaurasht.ac.ir

conducted abundant researches during recent years in order to achieve thermal comfort through natural ventilation. According to these researches, natural ventilation compared with air conditioning has exhibited more favorable conditions and better compatibility with the environment [2]. Natural ventilation could reduce energy consumption in buildings and be used to cool off and improve indoor air quality. Therefore, it gained popularity in recent years [3]. However, high level of energy consumption, designers are looking for an alternative way to improve energy efficiency in buildings. Natural ventilation has been considerably noticed in the United States of America [4] since it could be used to maintain good thermal comfort and indoor air quality with no use of mechanical machines [5]. Natural ventilation is so good which could appear as a solution to save energy. In fact, the use of natural ventilation is not new subject and has been used for centuries. Natural ventilation could be used as free cooling which was introduced and implemented by designers as an effective alternative to the inactive ventilation [6].

Natural ventilation is set adjoining to the term "passive design" and points to designing a way to facilitate the use of renewable energy. Therefore, natural ventilation is one of the basic solutions to reduce energy consumption in building and improve the environment [7, 8]. Wind energy, amongst renewable energies in the environment, leads human body to a high degree of comfort. On the other hand, when an architect is devoid of clear understanding of the importance of passive design, he could not implement proper design of building in the early stages using strategy appropriate to climatic features [9]. Simulation wind tunnel using CFD technology enables designers to directly simulate wind for further design and analysis on samples and determine the wind performance [9, 10]. According to simulations carried out by other researchers in the era of natural ventilation, several attempts have been done to achieve improved natural ventilation in buildings by changing measures in the windows or adding window on the West and East fronts of building. The present paper aims to take advantage of wind energy and use it as natural ventilation. This is done for several reasons: firstly in Rasht which is a region with temperate and humid climatic condition, high humidity is one of the disturbing factors in thermal comfort. The present paper focuses on providing recommendations on the location of windows in present condition to create the best optimal efficiency of wind energy in residential homes. Therefore such questions arise:

- What is the effect of wind on natural ventilation to create an atmosphere and a place for human comfort?
- To what extent the size, location and form of windows effect the level of ventilation?

2. Literature Review

Today, in the wake of addressing climate changes caused by global warming, renewable energies have been discussed as key elements. It is also a significantly important issue in the policies of many countries which encourages the large economic parts to reduce dependence on non-renewable resource [11]. In other words, if renewable energy sources do not act to reduce the impact of damages resulting from global warming and climate changes on Earth, at least they should function as deterrents to its excessive growth. Industries associated with wind have dramatically developed from 2004 to 2010 [12]. Oropeza-Perez (2015) conducted a study on energy assessment of the performance of natural ventilation in buildings located in the central area of Mexico. The findings obtained from a simulation of airflow indicate that when natural ventilation is used, thermal comfort was assessed to be more than 90 % [1].

Chan, Che-Ani et al (2013) explained that level of customers' satisfaction of inactive projects for thermal comfort was in higher degree. The findings of this study indicated that application and use of passive design has to be considered in order to intensify the use of natural ventilation in office buildings [13]. On the other hand, Homod and Sahari (2013) focused on controlling the efficiency of internal temperature, relative humidity of air flow and its influence. The results showed that there is big opportunity to reach thermal comfort using inactive ventilation [14]. Zhou, Wang et al. (2014) believe that natural ventilation in residential buildings has great potential to save energy and improve the residents' health. The results of CFD modeling showed that energy efficiency could be optimized with natural ventilation [15].

Aflaki, Mahyuddin et al. (2015) conducted a study to examine natural ventilation compared with other passive design strategies in tropical climates in order to support this argument. The results showed that ventilation condition, window area to wall ratio and orientation of the building should be reviewed in future construction projects [16]. Konis, Games et al. (2016) conducted a study to demonstrate the use of passive design and energy optimization framework in order to reach optimized performance of daylight, solar control and natural ventilation strategies in early stages of designing architectural projects [17]. United States of America is one of the countries which has proceed in this area and enforced financial regulations which allow clients to purchase electricity and other renewable energies. Germany and Denmark also implemented a set of policies related to wind energy for further development of related

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