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Analysing Optimum Building Form in Relation to Lower Cooling Load

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Abstract

Energy consumption would be an enormous matter as the number of people is increasing worldwide and resources are limited. The focus of the designer would be designing the building form to ensure less energy consumption. This research investigates the relationship between optimum building form in decreasing the cooling load. The study is conducted using computer simulation analysis program Autodesk Ecotect. The experimentation shows the relationship between building elements and cooling load. The outcome of the research reveals that compactness and lower ratios of surface to volume do give significant impact. Based on the result is assumed that manipulation and selection of building form will help passively in reducing cooling load.

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Keywords: Building form; energy efficiency; cooling load

1. Introduction

High energy consumption correspondingly starts from inefficient used for energy. In future, usage of energy would be a vital matter, as number people are increasing worldwide, and resources are limited. With the standard of

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living enhanced, people incline to expect a better comfort level, which eventually the usage of the air conditioning system is a must. If the building is designed in such a way that it will enhances energy efficiency and comfort (Zhang & Lei, 2013), in a simple term the building can cool itself. There would be no need for installing air conditioning system that is large and expensive. Small and fewer air conditionings mean significantly less energy consumption and more savings on electricity bills. In Malaysia, most of all commercial offices engaged cooling systems takes up average 70% of the total energy consumption yearly (Ahmad & Abdul-Ghani, 2011; Suziyana *et al.*, 2013).

Markus & Morris (1980) stated that the designer of the buildings can have significant control over the building as merely by changing material and form of construction. Material changing can affect the U-value or insulation value while the building construction method would influence air changes and ventilation loss. The designer has full impact on the parameters considerations. There are numerous ways how the actual dimension of height length and span varies which resulting in the diverse total surface area of a volume. Two different building may have different surface areas and envelope heat loss, but both buildings may have the same size and materials.

This paper aims at exploring optimize building form and its component, that illustrates less heat gain and eventually lower cooling load. Shape, geometry and form of a building is influenced by the solar energy it receives as well giving impact to its energy consumption (Markus & Morris, 1980). The shape of the building has a significant effect on both construction costs, and energy costs of buildings (Mingfang, 2002; Ourghi *et al.*, 2007; Pacheco *et al*., 2012). However, deviation of energy values of the different shape are comparatively small, and window wall ratio shows a significant value compared to form as the heat gain enters mostly from an opening (Ferdous, 2012). Still, there is a high correlation between the shape of a building and its energy consumption (Ourghi *et al.*, 2007).

The compactness of a form can reduce energy consumption (Granit & Möller, 2008). While AlAnzi *et al*., (2009) use compactness as an indicator in assessing the impact of shape on energy performance. Building form and building envelope are the most important parameters affecting indoor climate (Hemsath & Alagheband Bandhosseini, 2015; Oral & Yilmaz, 2003). There is a less research on building performance of the form based on cooling load capacity. Most building research based on cooling would relate more towards improving air conditioning system capacity. While in other research context, building forms are explored more towards thermal comfort and solar radiation. Based on these reviews, most studies on building form directly related to building aspect ratios such as surface to volume ratios, width to length, window to wall ratios and compactness. Exploration of various variables can be perceived when building form is being experimented.

The development of building form throughout the architecture design process would undoubtedly provide a better impact of energy efficiency. The building shape development to achieve better energy performance is essential. Effect of heat gain externally and internally towards a building form is crucial. The building shape manipulation and changes will deter the heat calculated for cooling load. Therefore, it is significance to explore the optimum building form that specifically lowered the cooling load and improve energy efficiency.

1.1. Building form and energy

Building form, spatial layout and arrangement configurations that are planned towards energy efficiency and based on climatic data is considered as a passive response. Improvisation of energy used is not only on building orientation but influenced by the form of the building and ratio of the volume to a surface (Yeang, 2006). Size and orientation of the exterior envelope are the ones that exposed directly in an outdoor environment. These elements are determined specifically by the form that in turn affects the thermal performance of a building. Even cost and esthetic are influenced by the building form. Undeniably, selection of an optimum form, orientation, and envelope configuration can reduced energy consumption by 40% (Mohammed Hussein Abed, 2012; Wang *et al.*, 2006). Building form in architecture is an external appearance that can be identified, a reference to the internal structure and internal outline. The form usually includes 3d mass or volume and a defined shape that gives its outlook (Ching, 2007).