Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 62 (2014) 421 – 430

Energy Procedia

6th International Conference on Sustainability in Energy and Buildings, SEB-14

Impact of the Envelope Geometry on Cooling Demand in Very Airtight UK Dwellings under Current and Future Weather Projections

Yahya Lavafpour*, Steve Sharples

School of Architecture, University of Liverpool, Liverpool L69 7ZN, United Kingdom

Abstract

The Passivhaus strategy employs super insulation to reduce the heat transfer through the building envelope. It has been argued that super insulated homes are vulnerable to summer overheating risks, even in the current climate. The UK is expected to experience hotter and more extreme summers in the coming decades and the risk of buildings overheating may become very significant in future climate scenarios. The Passivhaus approach can use much of the solar energy from its relatively large glazing in south facade but this large glazing may eventually lead to overheating in summer time. The study used parametric design modelling to generate differently inclined facade geometries for south elevations. Each elevation was then simulated by means of dynamic building simulation software in order to examine to what extend inclined wall mitigate summer overheating risk for Passivhaus dwellings in the UK under alternative future weather projections.

Selection and peer-review under responsibility of KES International

Keywords: Passivhaus, Overheating, Inclined south-facade;

1. Introduction

In the design stage, architects mostly consider the geometry of the building as an aesthetic matter and ignore the importance of geometry in the energy consumption and environmental performance of the building. On

* Corresponding author. Tel.: +44-7572419938;
E-mail address: y.lavaf-pour@liverpool.ac.uk

Selection and peer-review under responsibility of KES International
doi:10.1016/j.egypro.2014.12.404

the other hand, sometimes the architectural aesthetics are being neglected due to an over focusing on energy efficient matters, which can result in cube-shaped homes with small windows. Nevertheless, energy simulation is mostly conducted after the building design stage and it is not integrated into design decision making [1]. Passive design choices in the early architectural design stage, when the architect tends to use sketching to generate and explore the first design alternatives i.e. equal to RIBA stage C of design [2], represent important strategies towards decreasing energy demand in buildings. The massing and shape of the building is one of the first passive features of the design and can be considered as a good starting point for any sustainable design.

Historically, a single detached house has typically been built in a cubic or rectangular shape. However, the hi-tech movement and massive improvement in material technology has allowed new forms and shapes in designing buildings. During the past decade there has been an ongoing interest towards nonrectangular and prismatic building shapes [3]. Buildings with prismatic forms have received great attention in architectural journals and had a dominant impact on the cities in which they are built (Fig 1). This study sets out to investigate to what extent the geometric form of a Passivhaus dwelling in the UK could mitigate the overheating risk for current and future weather scenarios. In this paper a particular focus was the optimum inclination of a south facade to make use of the geometry to self-protect the building.

Fig. 1. (a) Museum of 21st Century Arts by Zaha Hadid; (b) the new building of the Geodynamics Institute, Athens by Zerefos Tessas Architects [3]

11. Background and literature review

One of the main challenges in designing a Passivhaus is the forming of the large openings for the south elevation [4]. The Passivhaus Primer publication states “In order to benefit from the useful solar gains a Passivhaus requires the glazing to be optimised on the south façade with reduced glazing on the North façade” [5]. Passivhaus tries to benefit from the higher levels solar energy incident on the south façade (in the northern hemisphere), and so Passivhaus dwellings are designed with a large area of glazing on the south facade. There is not much glazing on north and east facing façades, and in most cases no glazing in the west façade to avoid discomfort heat gain through openings (Fig 2). Taking into account the climate change warnings from the Chartered Institution of Building Services Engineers (CIBSE) and Zero Carbon Hub [6, 7] these large openings, combined with very high levels of air tightness and thermal insulation, may lead to a summer overheating risk in the future, especially for the most at-risk cities, like London, where urban heat island impacts will add to the overheating problems [8].