Building and Environment 46 (2011) 2238–2246

Contents lists available at ScienceDirect

Building and Environment

journal homepage: www.elsevier.com/locate/buildenv

Experimental determination of thermal performance of glazed façades with water film, under direct solar radiation in the tropics

Abdultawab Qahtan [a,*], Nila Keumala [a,1], S.P. Rao [a,1], Zulkiflee Abdul-Samad [b,2]

[a] Department of Architecture, Faculty of Built Environment, University of Malaya, 50603 Kuala Lumpur, Malaysia
[b] Department of Quantity Surveying, Faculty of Built Environment, University of Malaya, Malaysia

A R T I C L E I N F O

Article history:
Received 17 February 2011
Received in revised form
4 May 2011
Accepted 5 May 2011

Keywords:
Glazed façade
Water film
Heat transfer
Sustainability

A B S T R A C T

An experimental investigation of a glazed façade oriented west has been conducted utilizing the Sustainable Glazed Water Film (SGWF). The experiments involved the following three parameters namely: the water flow rate, the type of glazing, and the solar radiation intensity. Two full-scale rooms were used, one as a reference room, with a fixed configuration, and the other as a test room, which could be configured in different ways. The ability of the SGWF to reduce the passage of the solar energy during the sunny hours and hence to limit the heat passage through glazing was analyzed. The aim of this paper is to examine the improvement in thermal performance obtained by the flowing water film over glazed façades. It has been found that the flowing water film on the glazed façade lowers the glazing surface temperature by 7.2–14 °C (average) and absorbs a portion of the solar energy resulting in decreasing indoor temperature by 2.2–4.1 °C (average). However, with increased solar radiation intensity, the SGWF provides a better level of efficiency in reducing the heat transfer indoors.

1. Introduction

For the past few decades, the architectural language has given more emphasis to the lightness and the transparency of buildings, heading towards fully glazed building envelopes [1]. However glazing is the easiest way for solar radiation to penetrate buildings and become trapped inside. Direct sunlight passes through glazed façades as short-wave (radiation), is absorbed by the internal surfaces of buildings and subsequently emitted as long-wave radiation (heat), which cannot pass through the glass to the outside. This produces what is called the greenhouse effect [2], which typically accounts for 15–30% of overheating in indoor spaces [3].

To address this problem many studies have been conducted worldwide and have suggested the solutions. The traditional solution which allows users to control solar gain, involves both the proper orientation of the glazing [4] and the installation of devices. In relation to the glazed buildings, the shading as an alternative that prevents heat gain and allows light and a view to the outdoor, involved: (a) fixed or movable sun-shading devices, either external or internal that depend mainly on the slat tilt angle, reflective material and its colour [5–7]; (b) compound the shading devices with double glazing system to achieve high reflectance values inside the double glass pane resulting in minimizing heat gain [8,9] and; (c) building shape towards the self-shading, where it has been found by Capeluto [10] that self-shading results in similar performance of using high-performance low-emissivity glazing on vertical façades.

However, this solution does not distinguish between daylight (visible range) and heat (infrared range). Particularly on the east and west orientations in the tropics where the solar altitude is low and horizontal shading can only be achieved by blocking the whole façade. East and West façades are generally avoided in the design of tropical buildings for thermal considerations [11], but this is not always affordable and acceptable due to the limitation of the landform and view aspects.

Although, air-conditioning makes sense for maintaining the indoor temperature, it has the disadvantage of increasing the demand for cooling energy. In Malaysia, for example, about 57% of energy consumption in the office-building sector is used for cooling [12]. Hence, as energy costs rise and more glazing is used in buildings, there will be increasing demand for alternative

Abbreviations: CG, Clear glass; TG, Tinted glass; IR, Infrared; *f*, Flow rate; SGWF, Sustainable Glazed Water Film; SCGWF, Sustainable Clear Glazed Water Film; STGWF, Sustainable Tinted Glazed Water Film; GBI, Green building index.

* Corresponding author. Tel.: +6 0108901542; fax: +6 3 7967 5713.
E-mail addresses: tawab444@gmail.com (A. Qahtan), nimk@um.edu.my (N. Keumala), raosp@um.edu.my (S.P. Rao), zulkiflee1969@um.edu.my (Z. Abdul-Samad).
[1] Tel.: +6 03 79675320.
[2] Tel.: +6 03 79674474.

0360-1323/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.buildenv.2011.05.001