Applied Thermal Engineering 37 (2012) 302–313

Contents lists available at SciVerse ScienceDirect

Applied Thermal Engineering

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

Energy evaluation of an horizontal open joint ventilated façade

María José Suárez [a,*], Cristina Sanjuan [b], Antonio José Gutiérrez [a], Jorge Pistono [a], Eduardo Blanco [a]

[a] Universidad de Oviedo, EDZE (Energía), Campus de Viesques, 33271 Gijón (Asturias), Spain
[b] Department of Energy, Energy Efficiency in Buildings Unit, CIEMAT, 28040 Madrid, Spain

ARTICLE INFO

Article history:
Received 17 August 2011
Accepted 18 November 2011
Available online 27 November 2011

Keywords:
Ventilated façade
CFD
Energy-efficient building
Solar passive design

ABSTRACT

The term "open-joint ventilated façades" refers to a building system in which an external layer of slabs or tiles (metallic, ceramic, stone or composite) is hanged by means of a metallic-frame structure to the exterior face of the brick wall, creating an air cavity between wall and slabs. The arrangement of slabs is such that it forms open gaps between them, allowing the surrounding air to enter and leave the cavity all along the façade. In addition to aesthetic and constructive reasons, the main interest of open joint ventilated façades is their ability to reduce cooling loads. This is done by the buoyancy effect created by solar radiation inside the ventilated cavity. This paper focuses on the energy performance of a typical open joint ventilated façade, comparing its temperatures and heat transfer fluxes with those of a conventional sealed air cavity façade. The thermal and fluid-dynamic behaviour of both designs have been analysed with CFD techniques and the results of the simulations conclude that open-joint ventilated façades can help to achieve substantial energy savings in climates with hot summers and mild winters.

1. Introduction

1.1. Motivation

In the global final energy consumption, the household sector accounts for a 29% share, which corresponds to a 21% share of CO_2 emissions [1]. Inside this sector, space heating and cooling remains the most important factor and it is responsible for more than half of the energy expenditure. These indicators underline the growing importance of the evaluation of buildings thermal behaviour and the pressing need to increase their energy performance.

The buildings envelope (façades, roofs, walls, windows, etc.) plays an important role in energy efficiency. The exterior building elements, among them the façades, act as barriers between exterior and interior climatic conditions, but they may also work as passive solar energy systems. This way they can help reducing energy requirements for heating, ventilation and cooling while maintaining adequate comfort (interior temperature and humidity).

Energy efficiency and Bioclimatic Architecture are two of the pillars of the Strategic Singular Project, named ARFRISOL (Arquitectura Bioclimática y Frío Solar ≈ Bioclimatic Architecture and Solar Refrigeration), organized and promoted by the Spanish Education and Science Authority. This project study the energy behaviour of five demonstration-containers (new or renovated buildings) located in five different climatic conditions.

The aim is to prove that by combining passive conditioning systems (ventilated façade, greenhouse, glass corridors, etc.) and renewable energy sources (solar energy, biomass, geothermal energy, etc.) it is possible to reduce more than 80% the conventional energy consumption as well as carbon dioxide emissions to the atmosphere [2]. Three of the five buildings have open joint ventilated façades; the E-70 building located in Madrid, is the subject of the present study (central Spain, continental climate, Köppen climate classification: Csa); the other two are located in Almería (Southern Spain, Köppen: Bsh) and Soria (Northeast of Spain, Köppen: Csb).

1.2. Description

The open joint ventilated façade (OJVF) is a type of exterior closure built over a brick wall (that works as a support) to which a metallic-frame structure is attached. On this structure, the exterior tiles (stone, ceramic…) are hanged, leaving an air chamber between them and the main brick wall. The term "open joint" comes from the small gaps left between the tiles; these horizontal and/or vertical open joints, allow exterior air to enter and to leave the chamber, effectively "ventilating" the façade.

The open-joint façade is a passive conditioning system. The solar radiation on the exterior tiles heats them up and activates convection inside the air chamber, thus generating ventilation with

* Corresponding author. Tel.: +34 985182366; fax: +34 985182456.
E-mail address: suarezlmaria@uniovi.es (M.J. Suárez).

1359-4311/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.applthermaleng.2011.11.034