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# Experimental analysis of natural convection in open joint ventilated façades with 2D PIV

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ABSTRACT

The main particularity of Open Joint Ventilated Facades (OJVF) is that they have an exterior opaque coating separated from the mass wall by a ventilated air cavity. The exterior coating material is arranged in slabs separated by open joints that enable exterior air to enter and leave the cavity all along the wall. Under radiation conditions (and negligible wind velocity) the natural thermal convection produces a chimney effect that forces external air to circulate along the air cavity at an unknown rate. As a consequence of this mass exchange through the openings, the heat transfer problem turns more complex: air motion and thermal field are strongly coupled and therefore highly dependent on geometric characteristics of the wall. This article reports the application of Particle Image Velocimetry technique (PIV) to measure the velocity field inside the air cavity of an OJVF model in laboratory conditions. Measurements were performed for the vertical central plane of the cavity, for three different heating conditions corresponding to $Ra = 5.92 \times 10^8$, $Ra = 9.19 \times 10^8$ and $Ra = 1.35 \times 10^9$, based in the channel height, and with a Re about $10^4$. Detailed information of the flow behaviour inside the air cavity are presented and discussed. Special attention is paid to the ventilation effect through the joints.



## 1. Introduction

The investigation of the thermal and fluid dynamical behaviour of Open Joint Ventilated Facades (OJVF from now on) has become very challenging due to the great acceptation that OJVF have received among architects in recent years. The reasons of this popularity are mainly aesthetic and constructive. However, energy saving arguments are becoming more important every day. As a consequence, the study of the energy behaviour of these construction systems has turned into a subject of a great technological interest. A good way to approach the particular energy behaviour of the OJVF is to compare them with other wall solutions whose thermal and fluid dynamical behaviour has been widely investigated and is well known. In traditional walls with sealed cavity, an air layer is enclosed between two layers of construction materials. The air moves in a convective loop gaining heat and raising near the hot layer (for example the exterior layer heated up by the incident solar radiation), and sinking and releasing heat along the colder. In ventilated façades, incident radiation produces a chimney effect that forces external air to circulate along the air cavity removing or increasing the heat from the enclosing layers, depending in whether the external air is cooler or hotter than the walls. The air mass flow enters the cavity through ventilation openings specially designed in the lower part of the façade, and leaves the cavity through the openings at the upper part. In the case of OJVF, the fluid structures become more complex because the air cavity is separated from the external air only by the exterior coating layer which is composed of slabs separated by open joints. The main difference with conventional ventilated façades is that the air can freely enter and exit the air cavity through the open joints distributed all along the façade.

Understanding the overall thermal performance and heat transfer processes of OJVF implies the understanding of the fluid dynamic and thermal behaviour of the flow inside the ventilated cavity. But, to obtain an accurate knowledge of the flow, elaborated experimental and numerical methods are required. Traditionally, technical studies concerning OJVF have been focused on construction solutions and in the properties of the component materials. Only in very recent studies from Sanjuan et al. [1], González et al. [2,3] and Millar [4], the fluid and thermal performance of OJVF has been investigated using numerical methods. The first authors performed three-dimensional simulations to study the fluid dynamic phenomena taking place in OJVF under solar radiation, and appointed a methodology to quantify the energy savings

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