EXPERIMENTAL STUDY AND ENERGY BALANCE CALCULATION OF VENTILATED CERAMIC TILE ROOF IN MEDITERRANEAN CLIMATE

João Ramos\textsuperscript{1,2(*)}, Luis Almeida\textsuperscript{1}, Rui Pitarma\textsuperscript{3}

\textsuperscript{1}ESTG, Polytechnic Institute of Leiria, Leiria, Portugal
\textsuperscript{2}Institute for Systems and Computers Engineering Coimbra (INESC Coimbra), Coimbra, Portugal
\textsuperscript{3}ESTG, Polytechnic Institute of Guarda, Guarda, Portugal
\textsuperscript{(*)}Email: joao.ramos@ipleiria.pt

ABSTRACT

The impact of natural ventilation of a roof cavity on improvement of the thermal environment and reduction of cooling load of a residential building is discussed. The roof is one of the main elements of the building’s opaque casing, where the choice of materials and the implementation of appropriate passive technologies determine the thermal performance of a building. An experimental study was conducted to observe the effect of cavity ventilation on the heat and mass transfer through ceramic tile roofs with vented eaves and sub-tiles. This paper refers an approach for building roofs with vented eaves, with a study of their thermal performance through a long-term experimental evaluation of the heat transfer in the different layers/roof elements and the airflow along the air-gap cavity. To this end, a test cell was designed and built. It was tested outdoors under variable weather conditions, and monitored continuously. Various tests and energy balances were carried out in order to estimate and compare the heat flux through the various layers of the roof, thus characterizing this technology, its energy efficiency and its relevance in the management of energy demand in buildings. Results showed that the air velocity in the air-gap correlates with the intensity of the solar radiation, increasing with it, and there is a reduction in heat transfer by conduction when the heat transfer by natural ventilation increases.

Keywords: Energy Performance of Buildings; Ceramic Tiles; Roof Cavity.

INTRODUCTION

The ventilation of a roof or an attic has become one of the greatest interests for building researchers in the last several decades. When attic ventilation is weighed for solar heat mitigation, the attic ventilation must concentrate on the removal of hot air from the attic. In the cooling of an attic by natural ventilation, induced air movement by solar irradiation must be pursued in depth (Hens and Janssens, 1999). In an attic’s natural ventilation, the buoyancy of hot air should be considered. This self-induction force acts favorably even when wind force is not available. In order to evacuate accumulated hot air from an attic, the literature clearly indicates that the most effective form of attic ventilation is a combination of ridge and soffit vents (Romero and Brenner, 1998). We can find several experimental studies with the particular objective of quantifying the thermal behaviour of roofs. With the use of test cells, experimental tests in transient regime have assessed their thermal performance, either through thermal insulation, or through ventilation solutions (Ong, 2011; Zakaria, 2011). The adopted methodology allowed us to characterize the dynamic regime of heat transfer from a sloping roof with vented eaves and sub-tiles. To this end, we resorted to the construction of a test cell.
that allowed us to analyze the roof’s dynamic behaviour, revealed by the temperature and humidity profiles in the materials or in the garret air-gap over time, when subjected to daily cycles of solar gain and nightly cooling variables in accordance with the actual atmospheric conditions. The methodology for the evaluation of heat transfer in this type of solution consisted of developing energy balances on different surfaces of the materials and the statistical treatment of the results obtained during the measurement period, in the spring and summer seasons.

RESULTS AND CONCLUSIONS

From the obtained results we can observe high thermal amplitude of the outside air, not having, however, the temperature inside the attic accompanied the strong nocturnal cooling (Fig. 1). Heat transfer was calculated and it was also found that the air velocity profile in the air-gap correlates with the intensity of the solar radiation.

![Fig. 1 - Comparison of the variation of the surface temperatures of the elements in the air-gap, according to the incident solar radiation](image)

ACKNOWLEDGMENTS

The authors gratefully acknowledge the funding by Ministério da Ciência, Tecnologia e Ensino Superior, FUNDAÇÃO PARA A CIÊNCIA E TECNOLOGIA (Foundation for Science and Technology), Portugal, with the following projects: PEst-OE/ EEI/UI308/2014 and PEst-OE/EGE/UI4056/2014 UDI/IPG.

REFERENCES


