STRATEGY TO USE SOLAR WALL IN TEMPERATE CLIMATE

Summary

Solar walls are utilized in cold climate locations with favorable results, or as ventilation in mild summers. However there are few studies about its use in temperate or humid climate. In this work, an experimental trial room was made in Uruguay, for a radiation accumulator wall. Over the glass protecting the wall, an automatized roll shutters was placed. Diverse strategies and configurations were tested, proving that the roll shutter use optimizes the behaviour of the system, favoring the isolation in winter nights and blocking the sun irradiance on the summer.
Key words: solar wall, control, temperate climate.

1. Introduction

A heat wall accumulator consists in a non-conductive wall oriented north in south hemisphere, with a cover of a transparent to irradiance material, but opaque to distant infrared. Numerous works recomend its use as an effective alternative for energy saving in locations where heating is far more important than refrigeration (Sami V. and Gassman J. 2006), discarding its use in hot climate, although their use for ventilation in mild summers is suggested (Liu Y. et al 2013, Ruiz Á. et al 2005, among others).

However, there are few bibliographic data about its use in temperate climate, as its the one in Uruguay, where average temperature varies between 11 °C and 25 °C, with extremes of 41 °C in the summer and -5 °C in winter (INUMET), with small variations depending on location. In orden to use solar walls in this type of climate, is necessary having more information about the performance of this technology in such conditions, for generate conceptual background and enhance its efficiency.

Works for mediterranean climate, a little colder than Uruguay’s one, assure that this systems has over heating problems in the summer, suggesting solar protection studies for said season (Stazi F. et al 2011; Abbassi F. et al 2014, among others).

Roll shutters and horizontal eaves provide control of solar incident radiance. This work studies different variations of their use in an experimental setup, where the measurements acquired are compared to those obtained through theoretical models.

2. Experiment

The experiment takes place in the Laboratory of Solar Energy (LES, for its spanish acronym), located in the city of Salto, Uruguay, at 50 m above sea level (Φ = -31,28 °, long.= -57,92). A compound of 15,7 m² was perfectly oriented North-South, East-West. A smaller compound of 7,5 m^2 was built inside the first one, with all walls, but the North one, being a layer of 10 cm thick expanded polystyrene. Instead of a north wall, a concrete beam of 15x30 cm base, 2 m long was built, where a 30 cm thick black adobe wall was mounted as a heat accumulator, as shown in fig. 1. This same face of the compound is covered by an ordinary glass wall (6 mm thick, transmittance under normal incidence of 0,85). Said glass has a 2 cm thick PVC roll shutter, with a programable automatized opening-closing system. The whole glass was placed on the beam using aluminium frames, covering the joints with rubber weather strips and silicone, in order to avoid mass and heat transference through them.

The shutter's support functions as a 20 cm width eave, blocking part of the direct sun irradiance at certain moments of the day in summer.

Fig. 1: Experimental setup. External compound with adobe wall oriented north, window and roll shutter.

The measuring system reads 23 temperature, 3 irradiance, and two wind speed values. All of the readings, but the wind speed ones, are acquired by the same data taker. Said measurements are taken simultaneously every 20 s, and the mean of 3 consecutive readings is recorded each minute. Temperature readings are taken by a PT1000 platinum resistance thermometers, with an uncertainty minor to 0,3 °C. Many measurements are being systematically processed, such readings consists in: Temperature in many compound spots, temperature in the wall and glass, radiant temperature, horizontal radiation, vertical radiation on the north wall's plane and inside the chamber between the adobe wall and the glass, air flow on the inside compound, and average wind speed over the glass.

3. Results

Four different configurations where used. Each of them on a period longer than 20 days, in order to ensure systems stability. Measurements where repeateadly taken in all stations for two consecutive years.

- Room without accumulator wall (scrolled down roll shutter).
- Room with accumulator wall (roll shutter up and a small eave).
- Room with accumulator wall, small eave and protection by night (scrolled down roll shutter in the nights).
- Room with accumulator wall by night and scrolled down roll shutter by day.

A numerical model was made with SimEdif application, a software developed by the Institute of non-Conventional Energies of the Universdad de Salta (Argentina). The parameters of the system were numerically determined. For the convection coefficient on each wall, the correspondent theoretical model of natural convection presented in "Incropera F. and DeWitt D.," was used. Adobe wall properties were taken from Silva J., 2004, Thermal Aspects of Adobe Households, a work done by Architecture Departmente of Regional Norte (Universidad de la República).

In Fig 2 Left, graph results of the model are shown, along with the experimental values of Temperature between the glass and the wall for a period of 10 days of june (winter). In Fig. 2 Right, results of the temperature inside the room for the same period of time are shown.

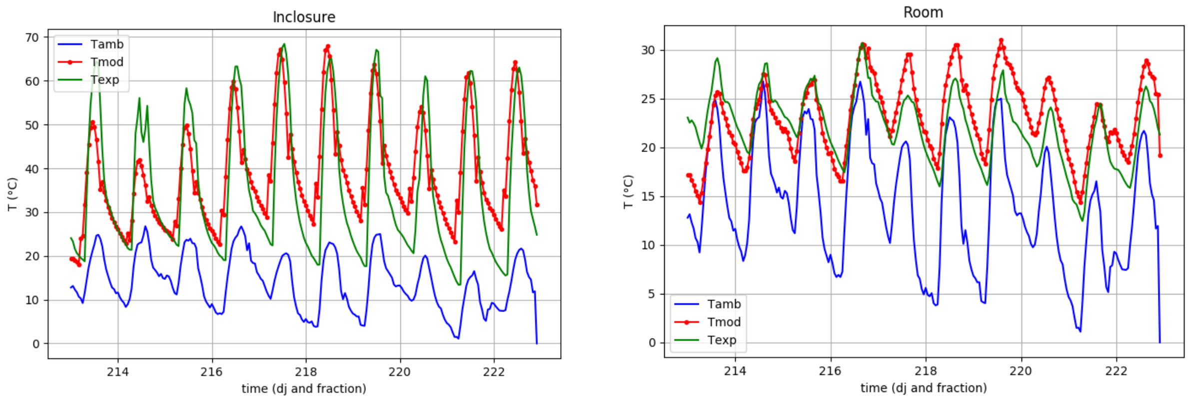

Fig. 2: In green, experimental dates; in red, numerical model results; and in blue, outside temperature. Left: dates of the temperature in the space between the wall and the glass. Right: dates of room temperature.

In the previous graphs the behaviour of the wall-accumulator is shown. The wall stabilizes internal temperature of the room, that was built with light materials. The prescense of the roll shutter optimizes the behaviour of the system, favoring the isolation in winter nights and blocking sun irradiance on the summer.

4. References

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