STRATEGY FOR USING SOLAR WALL IN TEMPERED CLIMATE

Vitale, Gerardo – gvitale@unorte.edu.uy
Bove, Italo – italo@fing.edu.uy
Flores Larsen, Silvana - silvanafloreslarsen@gmail.com

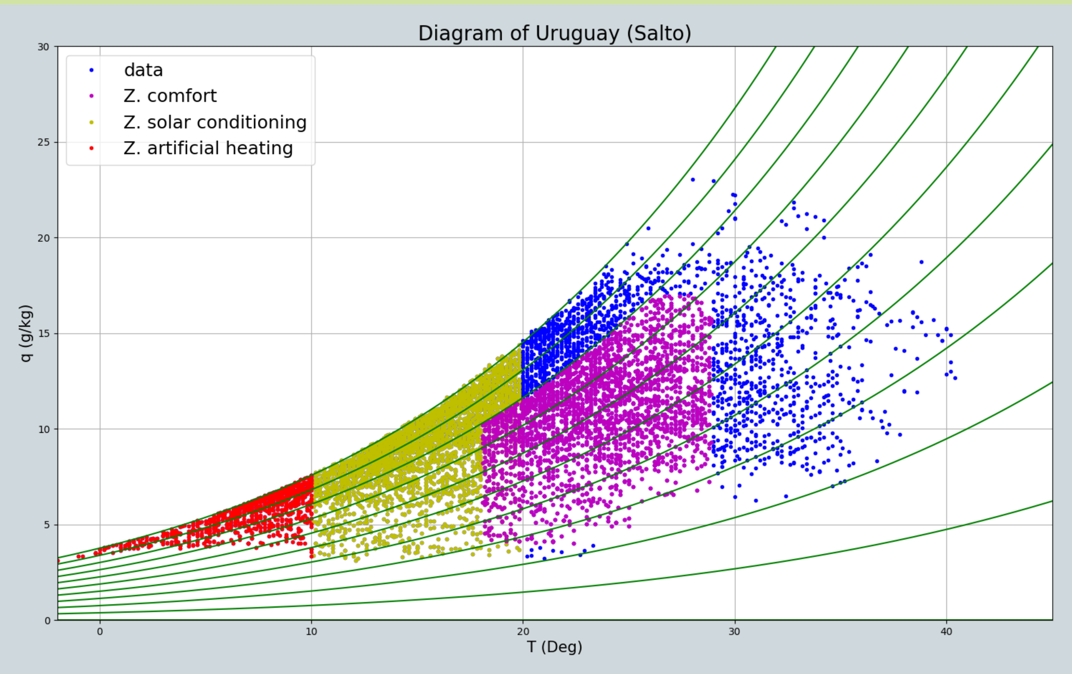
LABORATORIO DE ENERGÍA SOLAR, UNIVERSIDAD DE LA REPÚBLICA
INENCO CONICET U N S a
UNIVERSIDAD DE LA REPÚBLICA URUGUAY

EuroSun2018
12th International Conference on Solar Energy for Buildings and Industry

SUMMARY

The solar walls are used in places of cold climate with favourable results, or as ventilation in temperate summers. However, there are few studies on its use in temperate or humid climate. In this work, an experimental test room was carried out in Uruguay, for a radiation storage wall. On the glass that protects the wall, automated shutters were placed. Various strategies and configurations were tested, which shows that the use of the shutter optimizes the system performance, which favours the isolation on winter nights and blocks solar radiation on summer days.

URUGUAY: HUMID TEMPERED CLIMATE



Comfort	Solar Conditioning	Artificial Heating	Refrigeration
31%	43%	11%	15%

Uruguay is located in the southern hemisphere of the American continent. It is characterized by having a humid temperate climate. 31% of the typical hours are in thermal comfort, but in most of the year it is necessary to heat the rooms. In the psychometric diagram it is highlighted that 43% of the hours can be solved with solar heating.

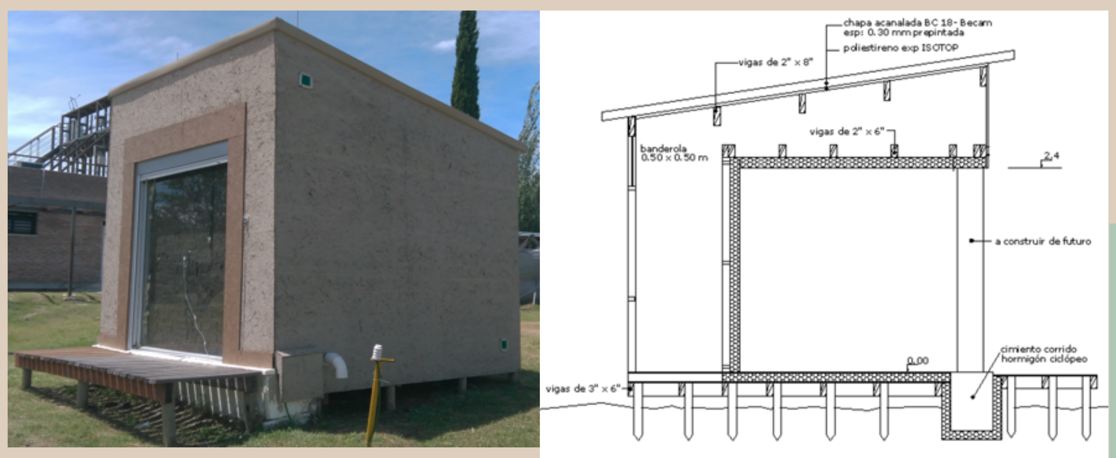
METHODOLOGY

This work has two main objectives:

1 - Assembling an experimental test room for a system with accumulator wall and acquire data for a long period of time.

2 - Perform a numerical model of the system using SimEdif, a program developed in the INENCO, and model the performance for different configurations of a Solar Wall in a typical meteorological year.

Experiment



Characteristics of the Wall

Material: Adobe.
Area: 4.63 m2.
Thickness: 30 cm

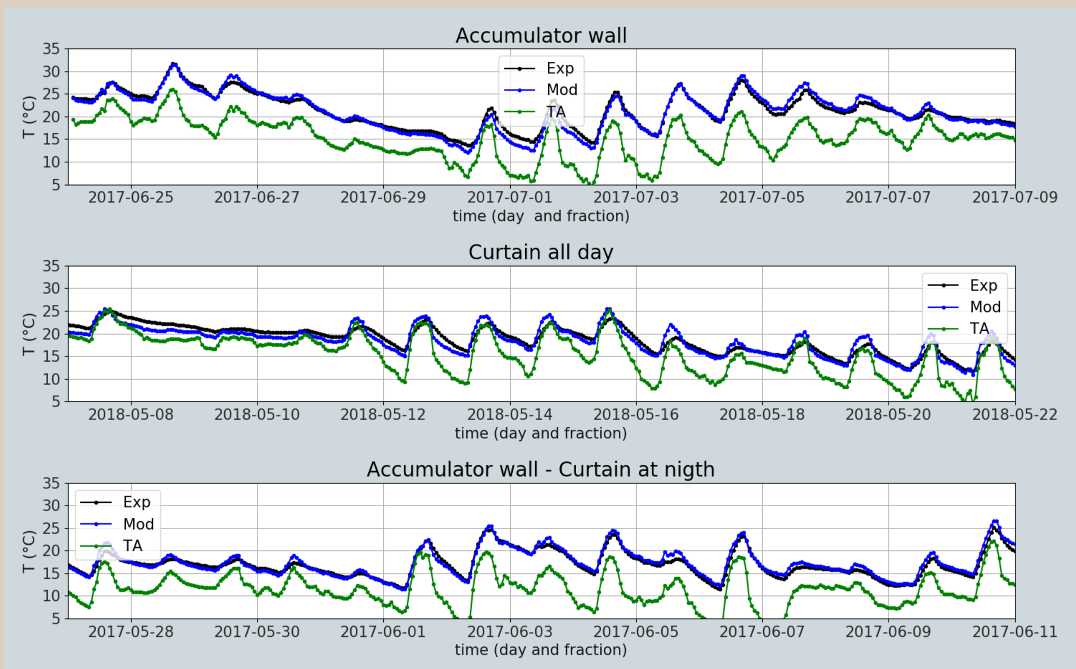
Measurements

28 Temperatures with PT1000
2 Irradiances with Licor Li-R100.
2 Heat flow sensors.
1 Weather station

Numerical modeling

The numerical model is made for three system configurations:

1 - Adobe accumulator wall without curtain protection.
2 - Adobe accumulator wall with insulating curtain all day.
3 - Adobe accumulator wall with insulating curtain all night.



Experimental data are taken and the numerical model is made for each configuration of the system. The graph on the left shows the performance of each model and the experimental data corresponding to the same period of time. For each model, performance indicators are determined.

Indicators of the models

$$RMS = \sqrt{\frac{1}{N}\sum(\hat{y}_i - y_i)^2}$$

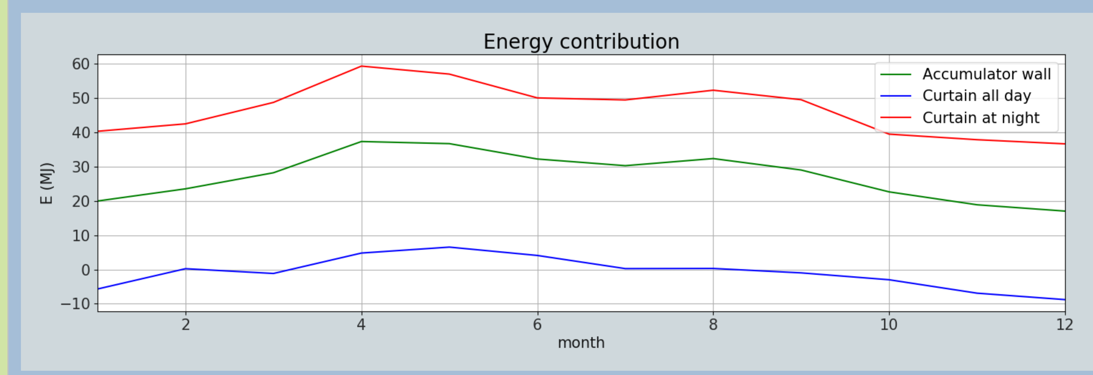
$$MBD = \frac{1}{N}\sum(\hat{y}_i - y_i)$$

y_i ➤ represents the measurement of temperature.

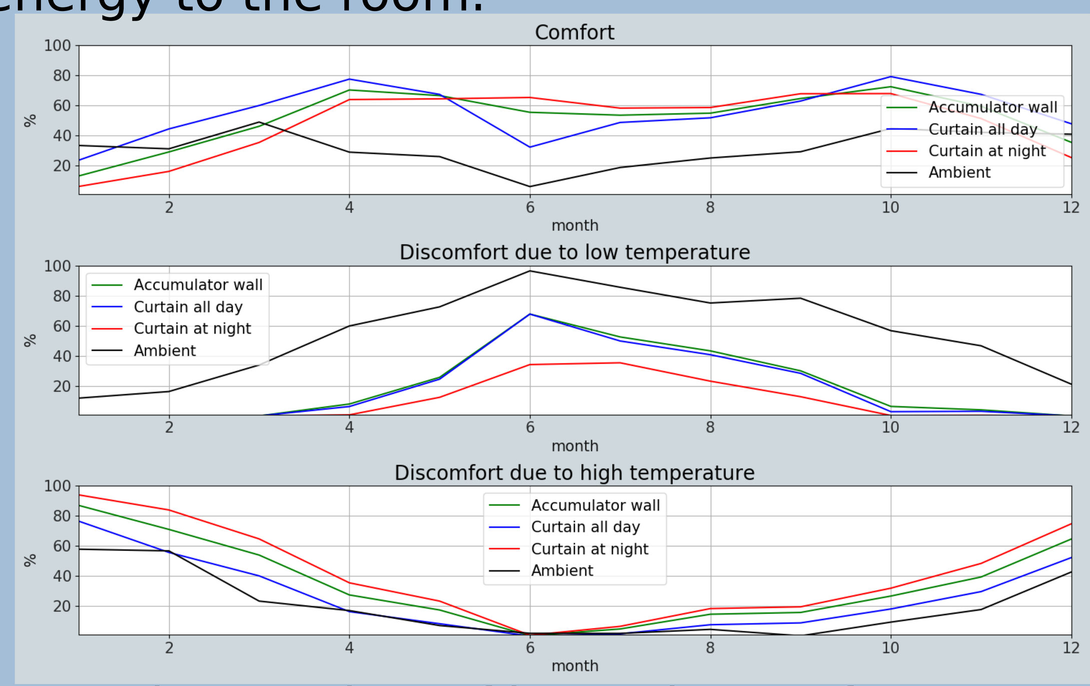
$\hat{y}_i$ ➤ represents the model estimate.

Setting indicators			
Configuration	**Without Curtain**	**Curtain All day**	**Curtain At nigth**
RMS (°C)	**1.15**	**1.63**	**1.92**
MBD (°C)	**-0.24**	**-0.47**	**1.00**

RESULTS



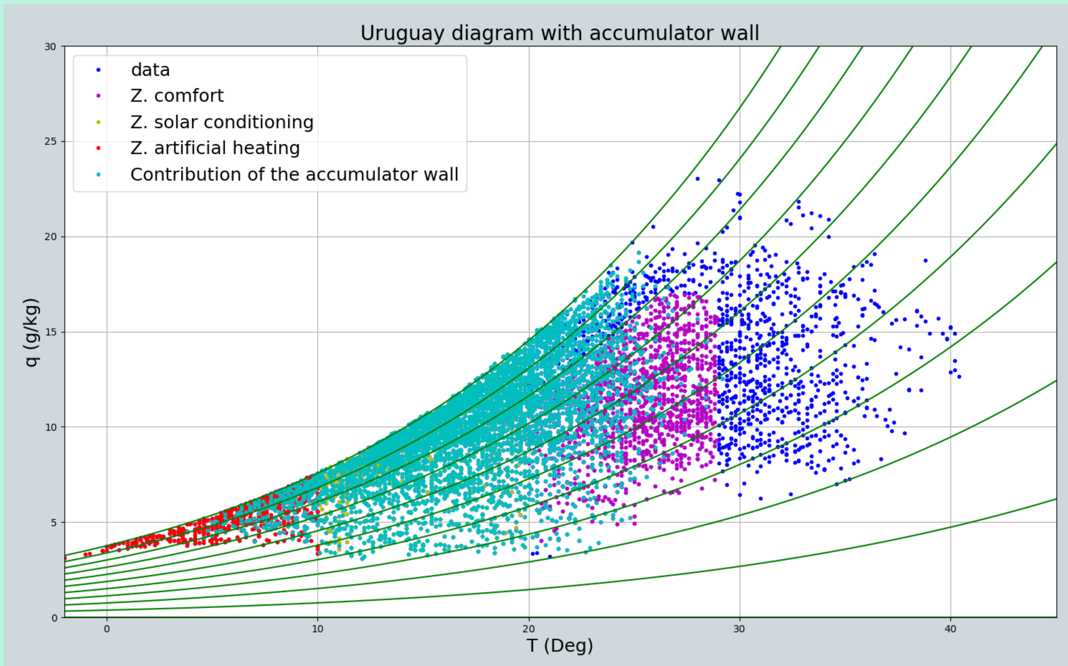
The graph on the left shows the contribution of monthly energy from the wall to the room. It is emphasized that with the use of night protection the wall contributes 50% more energy. Whereas with daytime protection the wall does not provide energy to the room.



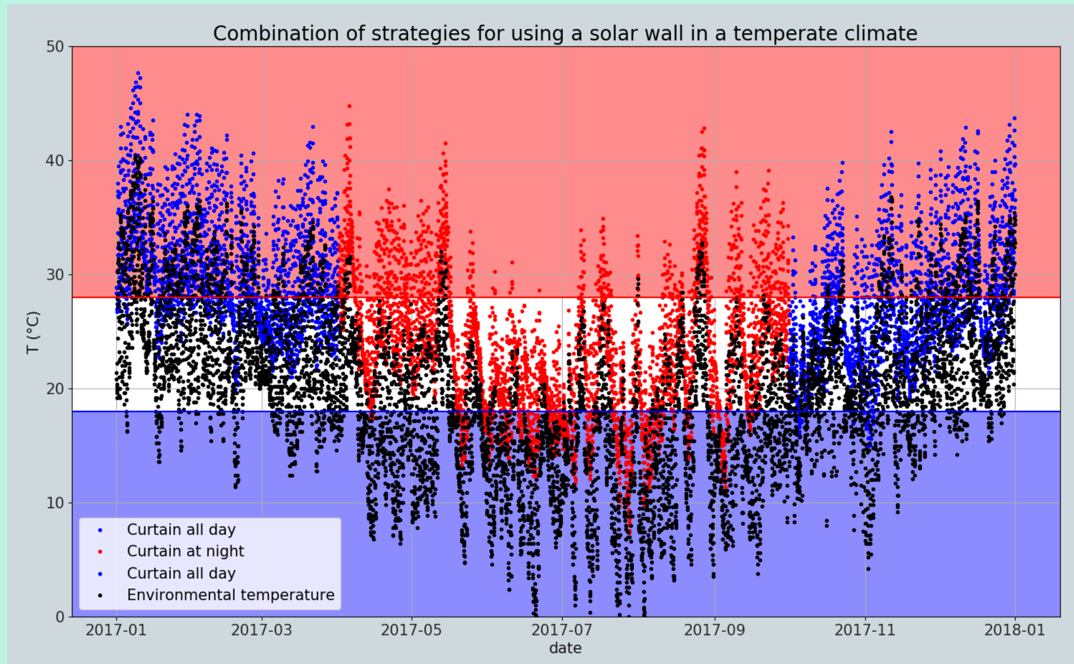
In the graph on the right, it is shown in percentages for each month the hours of comfort and discomfort due to low and high temperatures. Using protection in summer during the day increases the number of hours in comfort. Using protection on winter nights also increases the number of hours in comfort.
In summer, for this type of climate more than 50% of the hours are in discomfort due to high temperature or relative humidity.
Another consideration is that from April until October, more than half of the typical hours are in discomfort due to low temperature.

DISCUSSIONS

It was possible to assembling an experimental test room for an adobe accumulator wall. Quality measures were carried out during two uninterrupted years and with different system configurations.
A numerical model was made with SimEdif that fits satisfactorily with the experimental data.



Adobe is not the ideal material for this type of applications, but it helped us to adjust the model and understand the problem. This material was able to heat more than half of the hours in discomfort due to low temperatures.



The use of a curtain on winter evenings and on summer days increases the efficiency of the system.
In this work has not been considered air renewals, variable that can help improve the system performance in summer.
In the graphic above, a combination of the modeled configurations is performed.
From January to April the interior temperature of model 2 is placed.
Between April and October the model 3 and the rest of the year is returned to configuration 2.

REFERENCES

1 -- Abbassi F., Dimassi N., Dehmani L., 2014. Energetic study of a Trombe wall system under different Tunisian building configurations. Energy and Buildings 80, 302–308.
2 -- Incropera F., De Witt D, 1999. Fundamentos de transferencia de calor. Cap. 9: convección libre, p 481 – 516.
3 -- Liu Y., Wang D., Ma C., Liu J., 2013. A numerical and experimental analysis of the air vent management and heat storage characteristics of a trombe wall. Solar Energy 91, 1–10.
4 -- Ruiz Á., Salmerón J.M., Sánchez F. , González R., and Álvarez S, 2005. A calculation model for Trombe walls and its use as a passive cooling technique. International Conference "Passive and Low Energy Cooling for the Built Environment", May 2005, Santorini, Greece.
5 -- Sami V., Gassman J., 2006. Modelling Methodology to Analyze Passive Solar Performance of Trombe Walls. The 23 Conference on Passive and Low Energy Architecture, Geneva, Switzerland, 6-8 September 2006.
6 -- Stazi F., Mastrucci A, Di Perna C., 2011. Experimental and numerical study on the performance of solar walls in Mediterranean climates. World Renewable Energy Congress – Sweden.