Paramic Evaluation of Passive Housing: Thermal Adaptation to the Environment

Carlos Alberto Fuentes-Pérez[1]
[1](Academic Body of Quality of the Habitat / Autonomous University of Tamaulipas, Mexico)

ABSTRACT: *The typologies of residential housing could play a crucial role in the contemporary environmental architectural framework, due to the numerous attempts developed in the last ten years, to adopt a model of passive housing and climatic criteria in Mexico. The interactive and adaptive relationship between construction, site and climate is considered a basic rule to reduce environmental impact and improve energy efficiency in residential homes. This concept has been extended to the preservation of the cultural identity of places. The high level of adaptive, sustainable and functional performance of residential homes can be deduced, as evidenced by the case of the Municipality of Juárez, Nuevo León. The assessment of climate potential is one of the starting points for the design of residential housing. The objective of the present investigation is to determine in 2018, in the critical months of temperature that are January and August, the degree of thermal adaptation of residential passive houses in the Municipality of Juárez, Nuevo León.*

KEYWORDS *-Climatic adaptability, Passive residence design, Site and climate, Reduction of environmental impact.Thermal oscillations*

I. INTRODUCTION

The refinement of the architectural space plays a role in the energy balance of residential homes [1]. In this article we present a different configuration of the modification of the housing of the deep energy, we propose mainly the hierarchy strategies in the position of the power of the architectural design principles of the housing case study. These qualities are more important than those of the appropriate mode for the climate moderator [2].

In some cases, residential houses are the result of an intuitive process of in-depth experimentation, the development of climatic skills, learned from previous architectural models. The control of the climate in a residential home can be achieved through its orientation and flexibility of use, control of the shade, the sequence from the outside to the patio, ventilation and natural cooling, using direct methods of heat prevention and indirect dissipation of the heat [3].

Today, global warming and the sustained increase in energy prices have led to the search for residential homes with an efficient use of energy between designers and users. This has been accompanied by increasingly stringent thermal and energy regulations for housing. In addition to such changes in the energy front, building regulations have also been created or reinforced in other areas, including accessibility, fire safety and seismic risk, along with other demands made by the users. The combined effects of these two factors have madethe design of the construction much more complex [4].

The main thing that the present study affirms is that climatic tendencies, derived from the primary architectural decisions of the initial design phase, predispose the final energy performance of the existing residential dwellings. On this basis, the alternative reconditioning proposal called the architectural energy modification strategy focuses on the genetic energy code of these basic architectural features [5]. It is argued that its renewal and holistic refinement, both inside and outside, will pave the way for the energy renovation of housing and the regeneration of spaces [6].

The comfort within the case study of passive residential housing in the Municipality of Juarez, Nuevo Leon, can be achieved with less dependence on artificial lighting, mechanical ventilation, the application of ecological materials and that is excellent for absorbing heat and allows natural ventilation, providing warmth Comfort for users.

Therefore, designers are constantly looking for tools and information that provide them with ways to design high-performance residential housing for their projects. In response to these needs, this study proposes an optimization approach based on knowledge assistance to design high-performance residential housing. This approach provides architects and design offices with a clear knowledge of the potential of their project, the exploration of several options, which allows them to design the best possible high-performance residential houses, in this version of the approach, only energy is needed to achieve thermal comfort. This potential is evaluated through the parameters of external and internal thermal values, as well as the energy characteristics of the case study of residential passive housing in Juárez, Nuevo León.

Energy consumption in the housing sector is very high and is expected to increase even more due to improvements in the living standard and the increase in the world's population. Incorporating appropriate solar passive characteristics in climate sensitive residential homes are good options for energy conservation. This type of construction design integrates microclimate and architecture with the conditions of human thermal comfort and improves the energy efficiency of the residence. Since ancient times, people have used solar passive techniques in vernacular architectures around the world. However, there is still a lack of understanding, both in qualitative and quantitative aspects of solar passive techniques in vernacular architectures [7].

This study presents a parametric approach to the definition of an adequate form of construction compared to the heating requirement of residential housing in the first stage of the design process. A new simplified index is introduced, namely the neutral temperature coefficient Tn. In fact, with regard to climate architecture, the relationship between residential housing and the natural environment is very important both for the control of indoor comfort conditions and for energy requirements, [8]. The shape of the residential housing case study in Juarez, Nuevo Leon is a fundamental aspect of this relationship. In the thermal behavior analysis, this parameter is considered only from the point of view of thermal data compactness.

This is why we must register the concrete attributes and demonstrate the urgency that the practice of applying climate change mitigation and prevention measures must include the reform of the bad positions that appeared and that were nurtured in the architecture of residential housing, through a procedure of correct, directed, very precise mechanisms and adequate climatic diagrams with a small consumption of means, taking into account the present environmental conditions [9].

II. RESEARCHMETHOD

The present work is diachronic, because it analyzes the research problem in its genesis and historical conformation with an overall vision, which allows the establishment of the true causes that originate it, as well as the way it manifests itself in the process of its development.

Likewise, the investigation is a procedure that allows focusing attention on the behavior of the residential housing case study, to obtain broad and deep information, to contrast it thermally. Interview, observation, document analysis and thermal measurement are used.

Therefore, it is an experimental investigation applied to identify patterns of behavior of temperature and relative humidity only, not made previously in this type of residential housing in Juárez, Nuevo León.

The research allows dismembering, based on the research objective, an entire idea, with the purpose of discovering in the interior environment, temporary fluctuations of temperature and the relative humidity of the residential housing, establishing the degree of thermal adaptability.

The thermal behavior is the conductive thread of the investigation, by means of the factors that influence in the inner comfort of the residential house, by the tendency of the microclimate and its variations in Juárez, Nuevo León.

2.1 Determine the study area of residential housing

Based on the urban analysis and growth of the State of Nuevo Leon, it is determined that the study area for residential housing is suburban-rural, as it is presented in the study area in the Municipality of Juárez, Nuevo León Fig. 1 and the location of the residential housing study of case Fig. 2, of the present work.

Figure 1.Study area in Municipio de Juárez, Nuevo León.

Figure 2.Location of passive residential housing case study.

The residential housing case study is presented below in its four facades located in the respective cardinal points, see Fig. 3-7. The residential housing in total contemplates 1000.00 m^2 of construction in a suburban-rural land of 24 hectares.

2.2 Residential housing case study

Figure 3.North facade of the residential housing case study.

Figure 4.South facade of the residential housing case study.

Figure 5.East facade of the residential housing case study.

Figure 6.West facade of the residential housing case study.

Figure 7.Main access to residential housing case study.

2.3 Applied experimental research

Through the research carried out so far based on the need for congruence between the natural environment and the architecture; the theoretical and methodological foundations; the background and historical climate analysis and the development of the housing case study are determined as follows:

Because the present work is an applied experimental research, it´s shown in the document, the thermal values of the passive residential housing case study considering the activities and functions that are usually carried out so as not to interfere in the timely monitoring of temperature and relative humidity. It is determined that it will be evaluated at the respective seasons and its critical winter months in January; and summer in August, to determine the strategies of adaptability and thermal classification.

2.4 Evaluation of the thermal behavior by means of graphics with constant thermal comfort zone of the residential housing case study

They are evaluated considering the following:

- The typical months and days determining the excess and loss with according to the temperature variables, that are obtained from the neutral temperature *Tn*according to the model of adaptive thermal behavior of [10].

- The typical months and days of each month, determine the excess and loss based on the neutral relative humidity variable HRn, considering what´s stipulated in ISO Standard 7730, which ideally places it at 50.00%.

2.5 Graphics to obtain the degree of thermal adaptation

2.5.1 T and monthly HR with constant comfort zone

The thermal graphs of temperature and relative humidity in the air and of the residential housing case study and their respective spaces are based on the daily average values provided by hobo's UX100-003.This was tested for the interior and for the exterior the house that has the Micro station / datalogger H21, its values are considered as priorities, considering the critical months of low temperature in January and high annual temperature, in August and elaborated in a zone of constant comfort.

With this type of graph we determine the Tn-upper and lower limits-days of comfort, excess and thermal loss of T-thermal expansion, minimum and maximum T-HRc-upper and lower limit-days of comfort, excess and thermal loss of HR-minimum and maximum thermal expansion of monthly HR.

III. RESULT ANDDISCUSSION

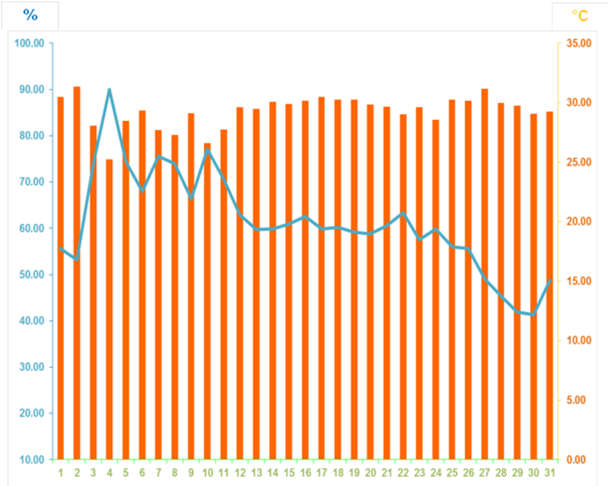

Figure 8.Air temperature and average humidity outside, January 2018.

Air temperature
Humidity Relative

Average air temperature 11.09°C
Average relative humidity 76.78%

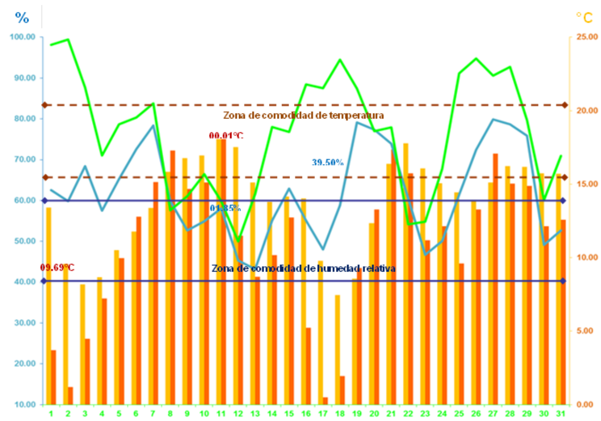

Figure 9. Areas of constant temperature comfort and relative humidity inside, January / Residential housing case study 2018.

Temperature inside HR inside
Temperature outside HR outside

Days of temperature comfort	12
Days of excess temperature	0
Days of temperature loss	19

Days of relative humidity comfort	17
Days of relative humidity excess	14
Days of relative humidity loss	0

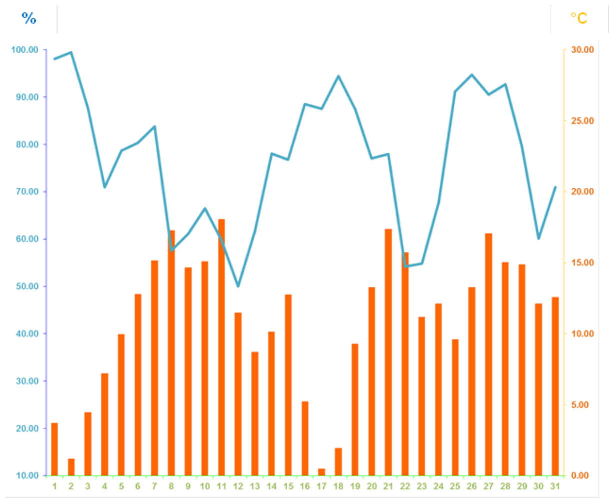

Figure 10. Air temperature and average humidity outside, August 2018.

Air temperature
Humidity Relative

Average air temperature 29.28°C
Average relative humidity 61.35%

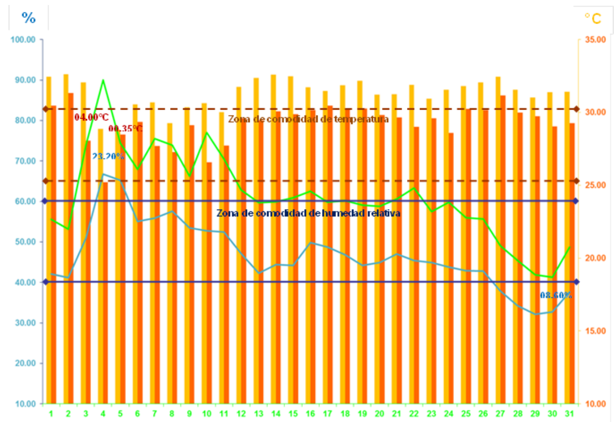

Figure11.Areas of constant comfort of temperature and relative humidity inside, August / Residential housing case study 2018.

Temperature inside **HR inside**
Temperature outside **HR outside**

Days of temperature comfort	4
Days of excess temperature	27
Days of temperature loss	0
Days of relative humidity comfort	24
Days of relative humidity excess	2
Days of relative humidity loss	5

IV. CONCLUSION

When seeing and measuring the oscillation of the conditions of the interior environment in the residential housing case study of the municipality of Juárez, Nuevo León Mexico and in its monitored areas inside and outside, it is determined that between the two variables studied, temperature and humidity, there is a linear correlation. However, it isinverse, in such a way that a change in one variable allows the change in the other to be adequately predicted. Although, the two variables move in opposite directions.

Based on the values established by the monitoring of temperature and relative humidity, a series of pending guidelines to be analyzed are presented below, since they were not a reason for the current investigation and at the same time they are aspects for improving the research objective addressed, this should be a subject of study in future research.

How to achieve the dehumidification of the residential housing in Juarez, Nuevo Leon Mexico?

How to involve in residential housing, constructive passive solutions that are combined in the minimum with the active, to obtain a hybrid operation and improve energy consumption?

What is the effect of the tropical mesoclimate on the breezes that are independent of wind currents, at the location of the architecture and its openings to the west?

What would be the participation of significant climatological parameters, such as air velocity and the determination of solar radiation and its relationship within the proposed thermal comfort zones?

V. Acknowledgements

In a formal way, I thank the deference for the support granted and the authorization of the Framework Agreement for Academic Cooperation of the Program for Professional Development, for the higher type that is subscribed to the General Direction of Higher Education University with the Autonomous University of Tamaulipas (UAT) for the accomplishment of the short stay for the investigation that at the moment was made in the Municipality of Juárez, Nuevo Leon. (Official Letter No. 511-6 / 18-6972).

REFERENCES

[1] E. Eliopoulou, & E. Mantziou, Architectural Energy Retrofit (AER): An alternative building's deep energy retrofits Strategy, *Energy and Buildings, 150(2),* 2017, 239-252.4

[2] K. M. Singh, S. Mahapatra & S. K. Atreya, Thermal performance study and evaluation of comfort temperatures in vernacular buildings of North-East India, *Building and Environment. 45(2),* 2010, 320-329.

[3] V. Pica & L. J. Garcia-Pulido, Bioclimatic behaviour of traditional domestic buildings in the Mediterranean basin. Some cases of study, *Ricerche di Storia dell Arte, 112(4),*2014, 67-105.

[4] T. Fabien,M. Pierre,A. Franck,M. Jean-Robert,E. M. Mohamed &V. Benoit, A knowledge-aid approach for designing high-performance buildings, *Building Simulation, 6(4),*2013, 337-350.

[5] S. Patidar, D. Jenkins, P. Banfill &G. Gibson, Simple statistical model for complex probabilistic climate projections: Overheating risk and extreme events,*Renewable Energy, 61(4),* 2014, 23-28.

[6] S. Claude, S. Ginestet, M. Bonhomme, N. Moulene & G. Escadeillas, The Living Lab methodology for complex environments: Insights from the thermal refurbishment of a historical district in the city of Cahors, France *Energy Research & Social Science, 32(2),* 2017, 121-130.

[7] K. Singh Manoj, S. Mahapatra & S. K. Atreya, Solar passive features in vernacular architecture of North-East India, *Solar Energy, 85(3),* 2011, 2011-2022.

[8] Y. Chen Cheng,D. Froehlich,A. Matzarakis & Lin, Tzu-Ping, Urban roughness estimation based on digital building models for urban wind and thermal condition estimation application of the Sky Helios model, *Atmosphere. 8(12),* 2017, 456-493.

[9] Z. Lazovic, M. Grbic & V. Djokic, The dissociation from the Giddens paradox in housing architecture in Serbia,*Energy and Clean Technologies Conference Proceedings, II(4),*2016, 615-622.

[10] M. A. Humphreys &F. Nicol, *The validity of ISO-PMV for predicting comfort votes in every-day thermal environments,*(Proceedings of Moving Thermal Comfort Standard s Into the 21 st Century. Windsor - UK. 2001).