Ventilation strategies as a solution in rural areas houses in hot climates.

S. Arias
University of Guadalajara, Mexico

ABSTRACT

This paper shows the analysis of ventilation impact in the energy behaviour in rural areas. Considering that a large percentage of housing production is self-built in this part of Mexico, the impact of this construction activity is very important. This concerns the thermal comfort of the occupants of this type of constructions, which has also effects in the microclimate of the region.
Due to the specifically local economy and the social structures, the self-built contributes in 60 % of the whole of production of housings. Due mainly to low-quality design solutions, self-built houses present on the whole a low environmental comfort standard. The principal consideration of this study is that the ventilation as design strategy for thermal comfort is very important to provide comfort to the occupants with hot climates in summer. Different ventilation techniques, as the simple cross-ventilation refers to conditions where a given space is connected by openings to both pressure and suction areas of the exterior. The movement of interior air flow this one determined by three principal factors: The size and the location of the openings (windows), his orientation with regard to the dominant winds, the presence of natural barriers, etc. And the constructive elements near the same ones. Go on to indicate that a great part of the houses relies only on the natural ventilation to solve the conditions of interior comfort.
Construction regulations do not indicate the necessary considerations to provide of natural ventilation in this type of rural houses. This study tries to obtain results that could use as reference to the local administrations to regulate the design and construction of windows and other openings to provide the interior comfort and the energy savings of the rural communities.

1. INTRODUCTION

Mexico is a large country with different climate variations. Their specific environment is the principal parameter to be considerate in the restrictions of shape and the characters of traditional houses in rural areas.

Figure 1: Traditional houses in rural areas.

This paper reviews the building constructions in the western region of Mexico and the features that have resulted from passive design concepts, strategies and technologies used for natural ventilation.
The contemporary architecture is used like example of internationalism. This attempt to suppress local traditions and to transform the urban context into an image without face. It is common not to pay attention to the architectonic traditions without taking into account that their contributions can be rich in content giving the harmony between the necessities to live and the environment where it is developed.

2. CLIMATIC PARAMETERS

As a first environmental approach to traditional architecture, the climatic limits necessary for achieving suitable ambient comfort were processed. The study area where environmental analysis, then proposals, was done is located at latitude of 20° N and a longitude of 103° W, in semi-temperate climatic conditions. The main axis upon which the present work turns is the relationship existing between atmospheric phenomena with the sun’s position (yearly, daily and hourly) being that which determines those environmental conditions to be considered in order to view architectural works in the context of their occupants’ wellbeing.

2.1 Monthly and seasonal variations.
The bioclimatic analysis of temperature and relative humidity data that were measured serve as a basis for determining climate control requirements for the 24

hours of the day during different months of the year. In the first six months, temperature and relative humidity oscillations may be clearly observed. Due precisely to this oscillation, climate control requirements are based upon those first six months, which represents the coldest months requiring greater inertia, as well as the warmest months where cooling strategies must be adopted. In the second part of the year, climatic variations are not as notable as in the first. The solar circuits are similar in various months as compared with those considered in the geometric solar graphic analysis. (Arias / Avila , 2004)

2.2 Climate control requirements.

Variations in thermal oscillation represented in this table are the result of processing the data collected in the region; here one may appreciate the different temporal periods where additional climate control is required. The proposal for also using relative humidity data is aimed toward incorporating all the results from this table into the first six month's solar graphic, and to geometrically obtain different exposures where it will be necessary to either maximize benefits from, or protect against, solar gains. This schema shows the weather's behavior through time, which is translated into various zones of climatic requisites – from the need for heating by natural means to ventilation and humidification which may be addressed with passive systems. (Arias / Avila , 2004)

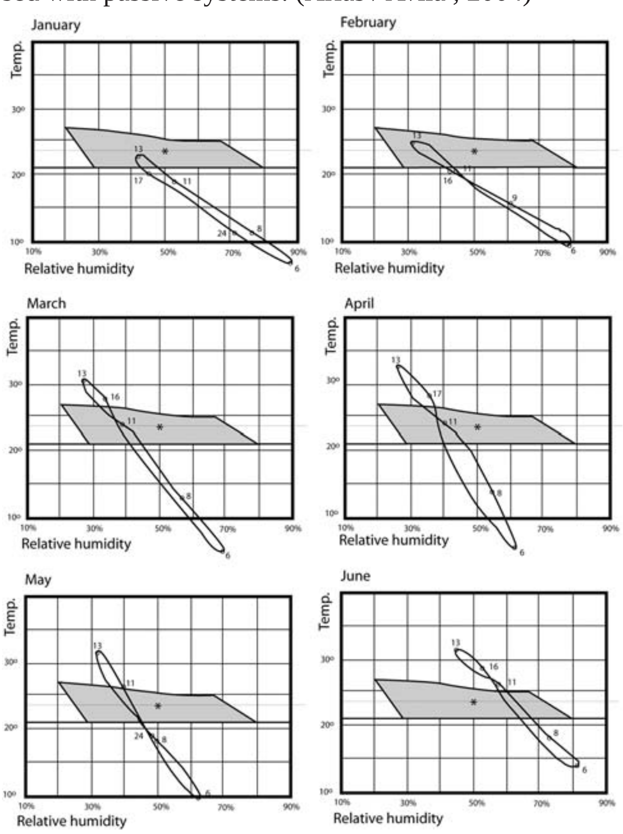

Figure 2: Bioclimatic behavior.

If this data is employed graphically, the bioclimatic situation for the site in question is obtained; utilizing the results season by season, it is possible to create design strategies that will counteract possible sensory discomfort. In other words, by identifying adverse environmental conditions and determining comfort factors as well as various design alternatives, specific design of bioclimatic control strategies as they are needed then becomes viable. (Arias / Avila , 2004)

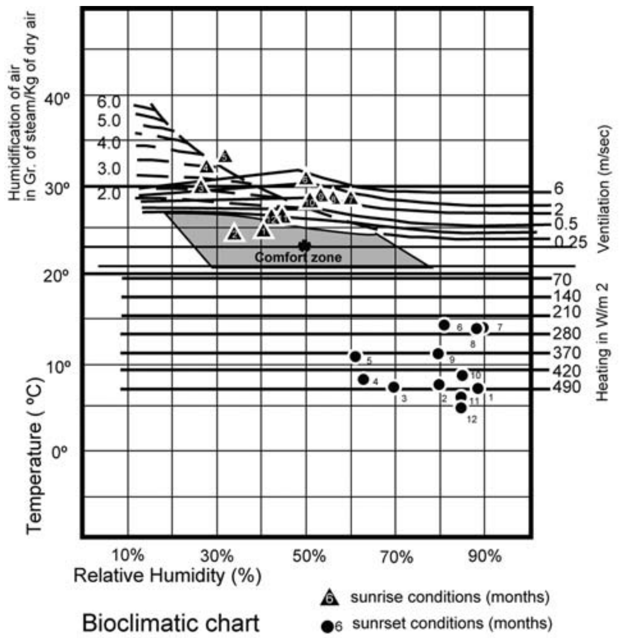

Figure 3: Bioclimatic requirements.

3. ANALYSIS OF THE FORM AND NATURAL VENTILATION

Analysis of the morphology. The procedure of physical analysis that next is developed contemplates the variant of the ventilation, to which it has occurred to determine like "eolic axis" that represents the direction of prevailing winds of a certain region.

Figure 4: Form and natural ventilation .

From here, also the most suitable direction of the different facades will be determined, of the analyzed forms. All the previous parameters take part in the environmental comfort of the internal space, but also it is to indicate the fact that the different disposition from the geometric element at issue will help to modify of equal way this comfort. The constructed cubic meters can such be, but making vary its volumetric development the thermal amount of gains or losses is modified simultaneously, that as in the example shown it is observed that in volume (m3) = B here, but in surface of thermal pick up B A

On the other hand, the form and height of the building also modify the movement of the air around the buildings; for long buildings, most of the wind is turned aside towards the superior part. In the case of high buildings, the air happens through the lateral parts. The form of the ceilings also affects the size of the protected area; the depth of the "shade" was increased according to the slope of the ceiling. The configuration and direction of the building cause a series of effects in the patterns of behaviour of the movement of the air; these effects alter the structure of the outer atmosphere and inner, consequently the consumption of energy of this construction is seen also affected drastically. The catalogue of the diverse configurations and the variations in the direction are extensive; the basic principles of the control of the air movement are used in the development of the analysis of the primary forms of the constructions.

The analysis of the form in relation to the bioclimatic impact that entails, must of being morphologic and not like a simple geometric problem; the capacity of pick up of the solar incidence in the surrounding one will be the main factor to take into account. The direction to that the greater surfaces are exposed will have then to be controlled according to the existing requirements of air conditioning; if these directions are adapted, will be smaller the climatic impact in the interior. In order to consider morphologic the index suitable, it is necessary to study the coefficient of Cf form; this coefficient is defined as the relation that exist between the surface of the surrounding one and the volume of the space:

$$Cf = \frac{Se}{V}$$

This coefficient is directly based on the volume; in quality and amount, that is to say, this related to the differences of geometric forms, but also to the size of these forms. As it is known, the lost ones of internal thermal energy are consequence of the morphology of the building in the same way that takes part the level of isolation of the same one.

The study of the morphology been always has limited the discussion on the geometry of the volumes; it is important to return to indicate the number of factors that can modify the conclusions on the suitable morphology is variable. All these factors take part directly or indirectly in the internal solar contributions. The factor of the phenomenon of the wind is one of most delicate analyzing, since it entails in himself a series of sub-factors (as they are the parasitic infiltrations, required air renovations, etc.). The morphology of the building directly takes part in the control or the advantage of the ventilation. In compact and heavy morphologies, the physics of the phenomenon increases the consumption of electrical energy for artificial illumination that palía the lack of natural light. The following table summarizes of general way the factors that take part in the set of the analysis of consumption of energy in relation to the morphology of the construction. (Grant, 1981).

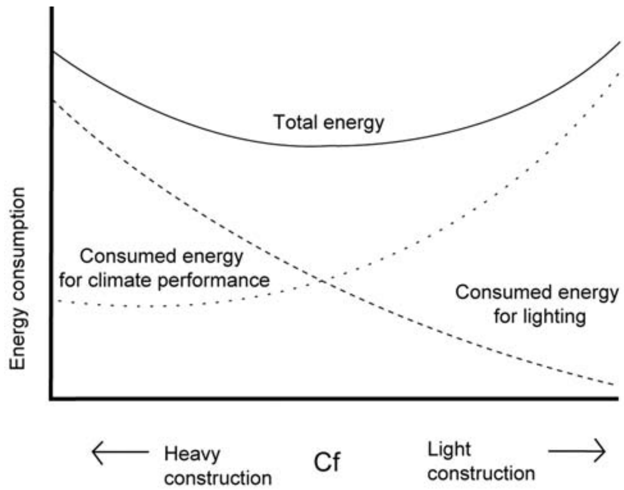

Figure 5: Consumption of energy in relation to the form.

As it is possible to be observed, the greater consumption of energy to climatizar is inversely proportional to the slowness of the construction (this is valid in climates temperings); and for the consumption of electrical energy for illumination it happens the same in comparison to the type of slight construction. It is difficult to consider a standard only of Architectonic space, still more in the habitacional sort, but what it is analyzed later they are indeed types of constructions that could well be habitacionales and its relation with the energy consumptions to climatizar and/or to illuminate.

3.1 Horizontal and vertical compartmentation.

Other two aspects that take part in the greater or smaller degree of comfort sensation are those of the relation levels and entailment that can occur between the diverse spaces (according to its direction) that compose the total of the architectonic construction at issue. This comes dice to that the power interchanges from a space to another one will be in direct connection to the relation and entailment that exists between both; between greater it is the existing relation between the spaces, of that same form the thermal phenomena of stratification and convection inside these will occur, and also in case it exists more entailment between the spaces greater will be the power interchange. (Serra, 1989).

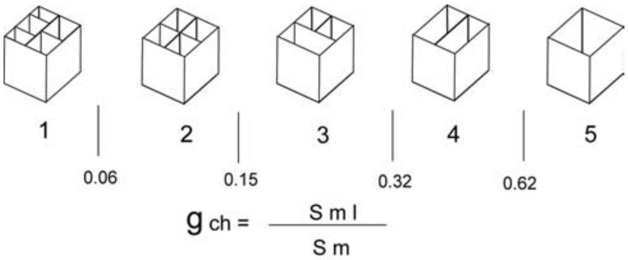

Figure 6: Vertical compartmentation

3.2 Vertical compartmentation.
The vertical compartmentation characterizes by the subdivision in this sense of the interior of the space, creating secondary spaces by means of separating elements; ceiling, plafond, etc. Where Sml is the average surface of the different spaces and Sm is the average surface in plant of the total of the construction (m2).
Horizontal compartmentation. On the other hand, the horizontal compartmentation subdivides in that same sense in greater or smaller degree the total of the construction; existing a greater compartmentation in plant, there will be less possibilities of than a thermal flow between the different resulting subdivisions is generated. Where Hm is the medium altitude of the floor (TM) and H is the overall height of the building (TM).

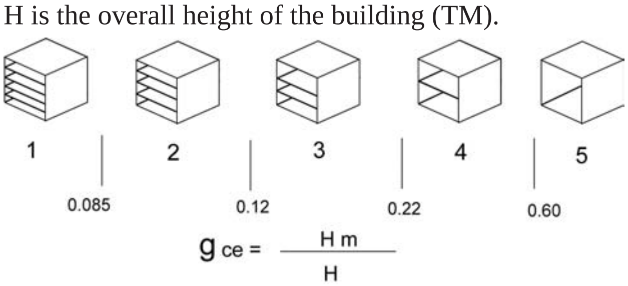

Figure 7: Horizontal compartmentation (Serra, 1989)

The space compartmentation also influences directly in the behaviour and speed of the ventilation in the interior of the space. All the divisions more even affect the patterns of behaviour of a significant way and in the speed of the flow. Consequently, these divisions must be arranged to optimize the required ventilation.
The suitable disposition of the space divisions will cause then one more a more effective ventilation; these divisions can be used to interrupt or to conduce the air flow, although with it is reduced to the speed and the energy of this flow, or as it can be counter-productive.
Baruch Givoni has investigated the effects caused when subdividing the nears space in 2 unequal divisions. In all the examples of these divisions, the wind direction is perpendicular to the manway and the internal speeds vary from the 5 to 98% of the outer flow. (Givoni, 1976).

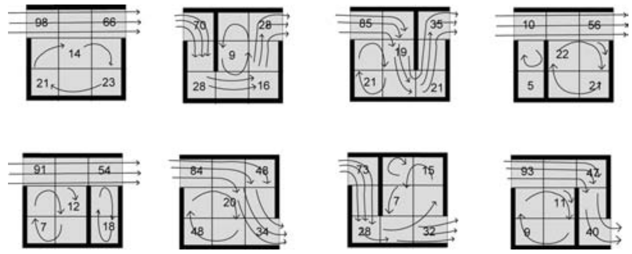

Figure 8: The numbers indicate the percentage of speed in relation to the outside.

"The speeds are low when the divisions are opposite and near the manway, therefore the air must change almost of direction when entering, but better conditions are obtained when the division is near the exit opening". According to the made test results, the divisions in nears space must be located near the outer openings to optimize the ventilation. Thus also, when the manways and exit are not aligned must consider the behaviour of the ventilation in the outside.

4. DESIGN OF WINDOWS

In the adapted design of windows three factors are considered mainly: the controlled solar gain, the natural illumination and the ventilation. For each case concrete data of analysis exist: With respect to the controlled solar gain it is required of the analysis of the equidistant solar graph. For the illumination the angle is taken from the solar declination with respect to the earth. In the case of the ventilation they are necessary wind graphs, its speed and direction of such.

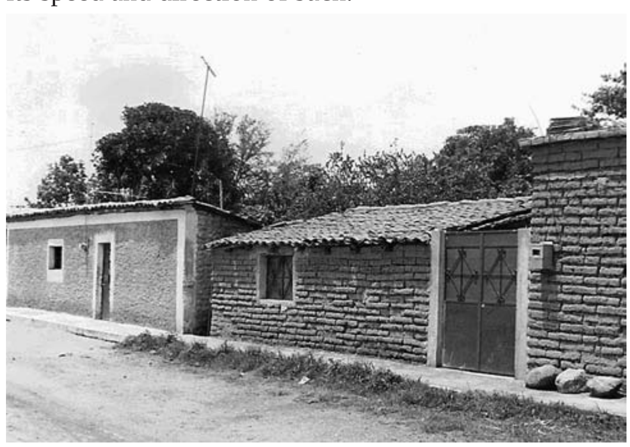

Figure 9: Window - Angle of incidence wide relation.

4.1 Solar gain.
On the basis of the solar graph with requirements or

protection a previous sizing of windows sets out.
Recommendable location in the respective wall. The zones are due to take care of you criticize to protect; to locate them in such a way that they avoid or they allow the solar gains according to is the case. These zones are observed in the solar graph of 1er. Semester and of geometric way the angles of penetration for each facade are obtained. Effects of the wind direction. The use of the oblique wind can be very advantageous in the case of study, where from the bioclimatic point of view he would be very difficult and inadequate to orient the East-West thermal axis. Nevertheless, with the Aeolian axis finger is feasible to ventilate of crossed way and cants more with a solar control adapted simultaneously.

Wind direction	Size of the exit	Size of the entrance (% of the wall area)					
		1/3		2/3		3/3	
		Aver.	Max.	Aver.	Max.	Aver.	Max.
Perpendicular 90º	1/3	35	65	34	74	32	99
	2/3	39	131	37	79	36	72
	3/3	44	137	35	72	47	86
Oblique 45º	1/3	42	83	43	96	42	62
	2/3	40	92	57	133	62	131
	3/3	44	152	59	137	65	115

Figure 10: Speeds average and principles given by the relation of size between the opening of the entrance and the one of exit

The relation between the air entrance and the exit area is a factor that influences in the amount of the air and the inner speed of the flow. If it is placed a great entrance and a small exit, the wind speed will be increased exactly where is the smaller opening, due to the Venturi effect and to the pressure differentials in the outside. Also it will happen if it is placed a small entrance and a great exit, the speed will be increased. (Givoni, 1976).

Wide of the window	wind 90°	wind 45°
1/3	13	12
2/3	13	15
3/3	16	23
2 x 1/3	17	21

Figure 11: Window - Angle of incidence wide relation.

5. CONCLUSIONS.

Consequently, the suitable disposition of the internal divisions is due to think about function to the best advantage of the ventilation in spaces that therefore require it and to avoid it as far as possible in which they do not need it, sacrificing this way the peak efficiency of ventilation but without losing it completely.

Nevertheless the fact that is due to have well-taken care of when interpreting one better ventilation is obtained when the incidence is oblique, because if the opening of exit also this aligned to this incidence then will not take place the waited for air movements in the interior, solely in the direction of the openings, this case the best solution would be to locate the entrance in the oblique direction and the exit in one of the lateral walls, developing this way the formation of a circular current of ventilation. The size of the windows determines with the combination of the results of the solar gain analysis, the natural illumination and the ventilation.

ORIENTATION	SIZE	%	GEOMETRIC FORM
NORTH	small	20-30	vertical rectangular
SOUTH	regular	25-30	rectangular
EAST	regular	25-35	rectangular horizontal
WEST	small	20-30	rectangular horizontal
NNW	very small	15-20	rectangular vertical
SSE	wide	40-60	rectangular
ENE	small	20-30	rectangular horizontal
WSW	regular	25-35	rectangular horizontal

Figure 12: Recommended size and shape of windows.

The graphical one shows the result of three factors and in the table the obtained averages of the analysis are indicated. (Arias / Avila , 2004).

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