BIOCLIMATIC HOUSE FOR TENERIFE –" VENTILATION WALL"

M.Goluboff[1], E. Rodriguez[2], J.L.Castellanos[2], A. Baaliña[2], J.A.Santaballa[2], A. Arce[3], L García[4]

[1] EscuelaTécnica S.de Arquitectura,Univ.deLaCoruña-HealthyBuildings Workgroup-UIA-Spain
[2]Escuela S. Marina Civil, Universidad de La Coruña , Spain
[3] Departamento de Ingeniería Química.Universidad de Santiago, Spain
[4]Hospital Materno-Infantil"Teresa Herrera". La Coruña, Spain

ABSTRACT

The moonlike landscape and the heat of the site sugested us the creation of an oasis open to the northern cool breeths from the Northeast and to close our house toward the sun and torrid winds from the South. That´s how the idea of a curved wall embracing the house and a patio was born, recalling ancient stone proteccions for vineyards.
We transformed the stone wall into a complex element, forming a natural air-conditioning chamber which works as a breeze catcher and due to the design of it´s different elements, regulates the interior climate of the house.

INTRODUCTION

The house was designed for the Island of Tenerife, one of the islands of Canarias Islands. The islands are of volcanic origin and are situated in the Atlantic Ocean between 27°33´ and 29° 23´ North and 13° 20´and 18° 16´West
The house is located in the Southern part of the island ,seca and arid.Water falls 95,7 mm. to 243,5 mm in a year.
There is much sun and great visibility. Temperature is constant all the year being the media between 18,36 and 24,89 °C. The maximum variation between day and night temperature is 5°C.
Winds blow constantly from the ocean , from Northeast, with a media velocity between 7 and 8 m/seg. (25,2 to 28,8 Km/h). Some days in summer blows wind from South, carrying particles from desert, creating a yellow unconfortable atmosphere .

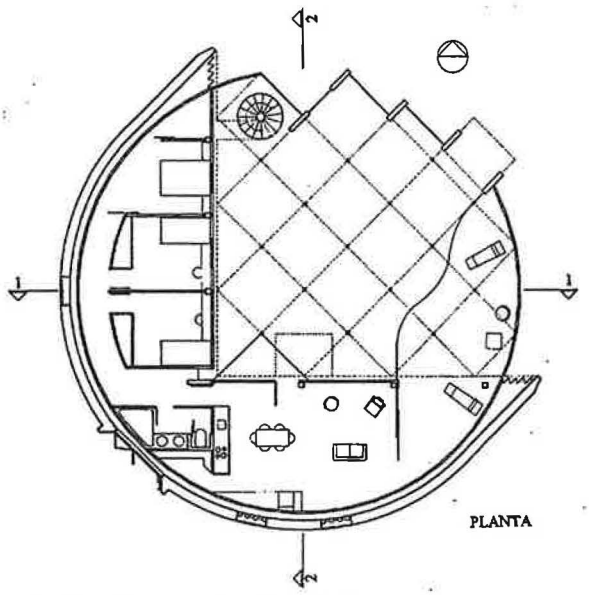
DESCRIPTION OF THE HOUSE

The house, composed of a living-dining room- kitchen, cupboard , partitioned bathroom and three bedrooms , is shaped as an L formed by two circular segments. The patio shaped as a quarter of a circle and the wall sorrounding the house, constitute the two main elements that regulate the interior temperature and ventilation in response to the different climatic situations.
The roof, being covered with earth and autochthonous plants isolates the house from solar radiation and acts like a lookout terrace. We designed the patio as a fresh and shadowed oasis. Since the terrace is seen from the high part of the ravin we wanted it to look like the sorrounding nature. There are three elements over the roof: an inclined plane supporting the fotovoltaic panels which guarantee the production of electric energy and whose cantilevering towards the patio mark the entrance of the house. A water tank designed as a " trombe" wall

guarantees hot water and finally a rooftop garden with a pergola wich creates an area protected from the sun and the wind relates the house to the landscape in all directions

EXPOSURE

The house is shut to the South with the curved wall that involves it,protecting it from the sun and the torrid winds of summer. The living room opens to the North and the bedrooms to the East. In that way we get an optimum exposure because the patio receives a fresh breeze from the Northeast regulating it through panels made of windbrace mesh which diminishes its forze permiting visual comunication with exterior landscape.
In the east side of the living-room, with northern exposure,there is a covered porch,which extends the living-room to the exterior .In the East side of the patio there is a pergola which is covered with plants that offer shade.
In winter, two openings in the round wall (" capture windows" in the living-dining-kitchen zone) let the sun enter. In summer they are shut.



In the Southwest side of the round wall, an opening lets the light enter during all the year. Its dimention and the thickness of the wall doesn't permit the sun to enter in the house

METHODS

We design the elelments of the house to resolve climate situation without mechanical elements.

THE WALL

The wall functions as an element that protects from the sun coming from the South and from the winds wich in summer days arive full of particles an dust from the desert. It acts as the ancient curve walls that protected vineyards.
The exterior side of the wall is made of stone and it has an interior partition made of wood . Both walls form a duct which chanels the air around the house.
The wall has different architectural elements that respond to different climatic situation.

In summer the wall acts as **ventilating wall** and in winter the wall acts as a **heat storage wall.**

ELEMENTS OF THE WALL

" Entrance openings": The "entrance mouths" at the two extremes of the wall have vertical louvers which adapt to the different needs in summer and in winte . There is a mesh which preserves the wall cavity from dust and animals.
In summer they receive northern wind which goes inside the camera, and goes away through ceramic tubes in "southern side mouth" of the exterior wall.
In winter mobile louvers of the "entrance mouth" are shut or in a position that regulates the entrance of the wind .

" Southern side opening ": On the southern side of the stone wall there is an opening formed by horizontal porous ceramic tubes which can be full of water according to needs.
When nortwest wind blows, tubes are empty and they let air go from inside to autside.
On very hot days, when the wind of the desert blows from the south, tubes are filled with water. Water falls like a cascade from top to bottom tubes, refreshing and moisturing air which enters the house through the louvers installed in the wooden side of the wall.
Water also cleans dust carried by those winds.
During winter a slattted shutter installed on the exterior wall regulates the circulating air.

" Heating window"
In the living zone, in the south side of the house there are two window-like openings. They are formed by a fixed glass in the stone wall which have behind it, some glasss tubes full of water , that recieve the sun and accumulates heat ,heating the chamber air and transfering it during the night to the interior through the louvers installed in the wooden partition.
During summer, because of the angular incidence of the sunrays the "heating window" doesn´t receive sun.

"Regulating louvers in the wooden side of the wall"
They suck-in the air which enters through the patio and goes away through "southern side opening" or viceversa depending on climatic conditions.

THE PATIO

The patio, with its pergola, its vegetation and its closing elements, acts as a regulating element of the wind from Northeast.

THE ELEMENTS OF THE PATIO

Closing elements: The Northwest side has a wooden partition which gives privacy to the patio. The Northeast side is closed by turning panels made of transparent plastic mesh used in agriculture as wiindbrace. In winter, being shut, they let the air pass but diminishing its velocity transforming wind in breeze and without interrumpting vision to outside . In summer they are open and permit that the refreshing air from the sea enter in a free way into the patio and through it into the house.

Pergola: Covered with Bougainvillea and Jasmine, creats a shadowy, colorful and perfumed atmosphere which contrast with the roughness of entouring landscape
Plants: In the patio and the terrace there sould be plants adapted to the zone : Dracaena draco. There should be a dripping system for irrigation for the time when it is necessary.

VENTILATION SYSTEM

Taking advantage of the great climatic stability which offers the zone, having constant and intense wind from Northeast ,during almost all the year, it´s possible to guarantee the natural ventilation of the house.
For that reason we create a double exterior wall which forms a rectangular section duct to capture exterior air taking advantage of it´s own velocity by means of the adecuate exposure and direction of the "entrance openings". This duct have mobile louvers in the wooden interior side of the wall where the exterior fresh air enters the house.

RESULTS

Taking into account that for each square meter of the house we need an average amount of 25 m3/h, as we have in this case 120 m2 surface and 315 m3 volume , we need a total air flow of 4.000 m3/h. In this way we can guarantee 12 renovations per hour.
Considering an average velocity of the wind between 3 and 5 m/s and taking into account that the "entering opening " has a surface of 0.6m2 (2m.high and 0,30m. width) we can get a ventilation air flow between 6.480 and 10.800 m3/h for each "entering opening" . This amount is more than enough to satisfy the ventilation needs of the house.
To make possible the circulation of the air inside the house we have loouvers in the wooden interior part of the wall .

We verifyed the dimention of the cavity of the wall calculating the loss of energy.

LOSS OF ENERGY

In this case losS of charge will be of little amount thanks to the low density of the air and to the spaciousness of circulation duct. We calculate the loss of energy as follows:
Calculus of hidraulic diameter D_h

$$D_h = \frac{4S}{P} = 0{,}51m.$$

where S represents the section of the duct and P the perimeter.

Calculus of effective diameter D_{ef}

$$D_{ef} = \left(\frac{64}{fR_e}\right)D_h = 0{,}4281m$$

where fRe represents the friction coeficient for regular ducts

Calculus of Reynolds number:

$$Ra_{ef} = \frac{V.D_{ef}}{\nu} = 1{,}07x10^5$$

Considering velocity V= 5m/s and the cinematic viscocity : v= 2 x 10^{-5} m^2/s
Calculus of relative rugosity

$$\frac{e}{D_{ef}} = 6.97 \times 10^{-4}$$

Appealing to the Moody diagram for these flux conditions and relative rugosity we obtain a friction coeficient f= 0,017 . So the falling of pressure will be:

$$\Delta_p = \rho\frac{V^2}{2}\left(f\frac{L}{D_h} + \Sigma K\right) = 0{,}030kP_a$$

$\sum K$
where . represents the lost of charge in the entrance, in the way out and those due to the duct curvature.

DISCUSSION

This design was done for an architectural competition, We couldn't verify our hipothesis as to be sure that the different elements work as we thought. It should be interesting to study that with simulating models.

But, in spite of that, we think that taking adventage of the great climatic stability which offers that place, that make sure the precence of Tortheast winds from sea almost all days, is really possible to guarantee good natural ventilation during all the year, domesticating it by elements in the architectural design. And that the cavity of the wall is an indirect good element to guarantee temperature and adequate interior temperature . But the wall itself is not enough to get that. In this case the patio and the turning panels of special mesh which close it complete the system.