A bioclimatic house in Buenos Aires

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ABSTRACT: The building is situated in a narrow urban plot, facing NW- SE, in the suburbs of Buenos Aires City at 34º S latitude.
The two- storey house is only 6.50 m wide and 17 m long. It has a double skin which regulates interior temperature, avoiding direct radiation. The interior box is rotated 5º related to the exterior box, leaving a space between both of them. This rotation generates shade on windows, especially those looking SW, preventing overheating in the inside in early afternoon.
As summer is humid and nearly hot, it is necessary to assure crossed ventilation. But, as main breezes at night, come from the river (NE), a ventilation device had to be designed to capture them. That is the reason why there is a double- high space in the middle of the house which works as a ventilation tower and as a skylight, as well. A suspended ceiling avoids dazzling, while lets the diffused light come in.
During the day, hot air rises through the tower, pushing cooler air in, from a pond in the front of the house and a water channel which surrounds the building. It collects rain water from the roof and can be use for watering.
The whole envelope, roof and walls, are conveniently insulated to reach the highest standards in thermal comfort, recommended in Argentina.

Keywords: energy efficiency, comfort, bioclimatic strategies

1. INTRODUCTION

The building is situated in the suburbs of Buenos Aires City (58°28' W, 34°38' S), with humid template climate, being the mean summer temperature, 23.2°C and the winter one, 11.3°C. It has been necessary to apply bioclimatic strategies as crossed ventilation; stack effect and protection from direct radiation to reach comfort in summer; enough isolation and protection from rainy and cold winds from south have been required in winter.

Daylight in every room, extra roof and wall insulation, thermal mass, crossed ventilation, and rainfall collection for evaporative cooling are some of the various techniques that have been employed to save energy (2).

2. THE PLAN

The building is located in a narrow urban plot looking NW (10 m x 38.50 m). (Note that we are south of the Equator!) The owner asked to place the house adjacent to the neighbour's SW wall— which is six meters high— in order to separate the maximum distance from the other neighbour's house, where a relative lives, to share a larger garden between the two houses as there is no division separating them.

Apart from that, the house is narrow enough to be sunlit in winter from the NNW as the relative's house projects shade over garden in between

This requirement meant to have the longest façade looking SW, instead of NE which would have been the most logical situation to get the best orientation.

The main problem to solve was this façade looking SW. It would be a large wall heated by solar radiation during summer afternoons and with scarce radiation in winter afternoons.

To improve orientation, the two-storey house is compound of two boxes, an outer box made of concrete blocks and another inner one made of ceramic bricks, which has been rotated 5° in N direction. This rotation lets the sunlight in when it is winter and avoids it in summer at peak time

This double skin generates spaces which work as complementary eaves to control sunlight, shading when necessary and protecting from SE rain as well as cold winds from SW(3) (5) (fig. 1).

3. THE SECTION

In the middle of the house there is a stack device to provide cooler air to come in from outside to refresh the house at night (6). The fresh breeze comes from the river (NE) at night and push warm air out. The device has movable metal screens to control air movement. The roof's shape facilitates the movement of air, preventing the income of cold air from SW direction (7)

There is also a skylight which lets sunlight inside the core of the house. To prevent glare, suspended ceilings at different levels have been designed (1) (fig. 2).

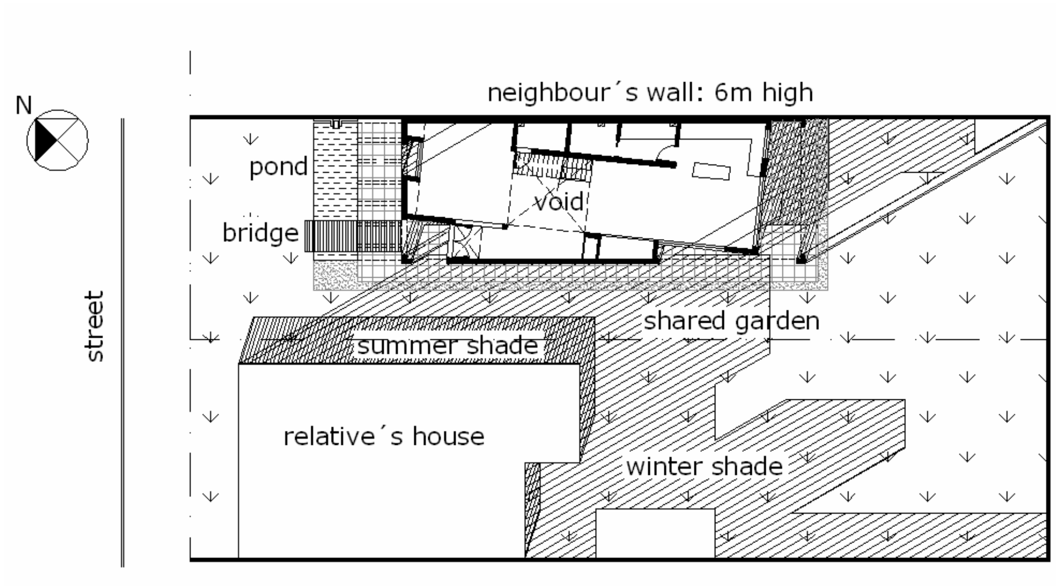


Figure 1: Floor plan with winter and summer sun at 2 pm

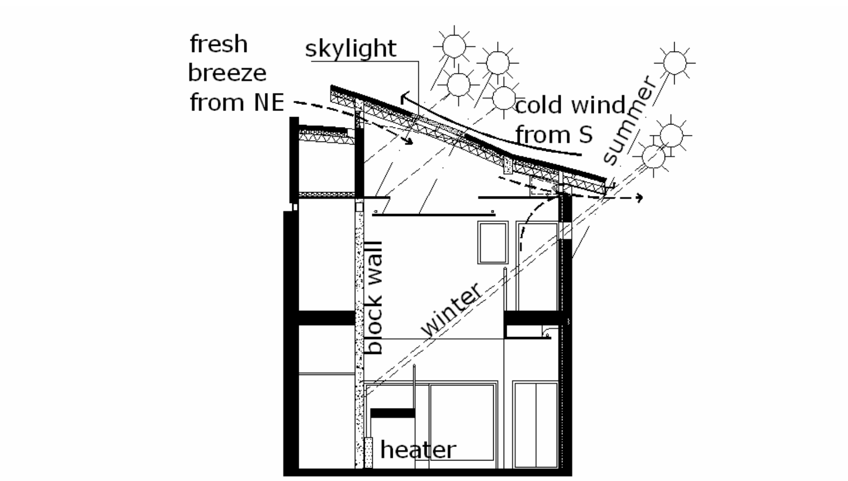


Figure 2: The stack device lets fresh breezes in through metal screens that can be regulated on demand

4. THE MATERIALS

The load-bearing structure consists of walls of concrete blocks and ceramic bricks.

As concrete blocks have got a poor thermal performance, walls are provided with vapour barrier, inner insulation of glass-fibre 10 cm width and gypsum board.

The employed ceramic bricks have got a better thermal performance than ordinary ones, so as not to need additional insulation. But they are more expensive than ordinary resistant ceramic bricks.

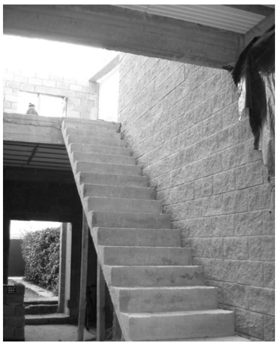
The roof is a metal structure of corrugated iron with 15 cm of glass-fibre. Below it, there is a closed air chamber with suspended ceiling which contributes to control temperature inside the house.

Insulation costs have been considered to obtain highest saving at least cost. Glass-fibre is the only material with a competitive cost, while expanded polystyrene or polyurethane foam are not convenient because of their price. Polystyrene has been used combined with concrete reinforced beams in upper floor working together as a load bearing system (Photo 1).

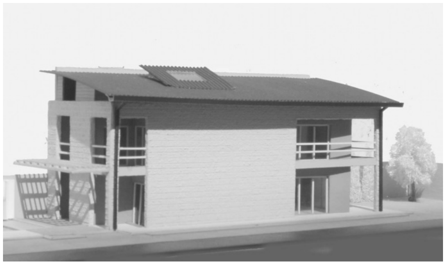
Photograph 1: Expanded polystyrene in upper floor and glass fibre inside double wall

Fenestration consists of aluminium double- glazed windows with metal blinds to provide shade and natural ventilation when necessary.

A two- storey high wall of concrete block provides thermal inertia accumulating heat in winter by incident solar radiation and delaying heating in summer when radiation does not reach the wall. Stone floor contributes to increment inertia. Besides, a heater has been placed by this wall to heat the two storeys through the void. Stairs have been separated 10 cm from this wall to let warm air rise (Photos (2, 3).



Photograph 2: The building under construction, viewed from the inner concrete block wall and stairs.



Photograph 3: NW view of the mock up. The stack device with the skylight can be seen in the roof

Photograph 4: SW view of the mock up. The SW wall is made of concrete blocks with additional insulation.

5. THERMAL PERFORMANCE

The Argentine Institute for Standardisation and Certification (IRAM) recommends building materials and techniques to get a good thermal performance but they are not obligatory. This lack of rules about energy efficiency and comfort makes very hard to convince private clients about these topics. This works as a typical barrier to energy efficiency and the use of renewable energy in buildings.

As the owner is going to live in this house, he will benefit with the reduction of the operative costs due to heating and air conditioning.

The building walls are very close to the highest level for argentine standards for winter and summer conditions (4) (Table 1). Losses and gains corresponding to building geometry, called volumetric G coefficient of heat losses (IRAM 11604), shows a good performance of the building (Table 2).

Energy consumption for heating is 101 kWh/year/m2.

Table 1: Thermal transmittance (W/m^{2}K) in walls and roof, calculated and compared to maximum admissible values according to two levels of IRAM standards 11601/11605 (1996)

U WALLS calc.	0.31
Winter	
IRAM Level A	0.29
IRAM Level B	0.77
Summer	
IRAM Level A	0.5
IRAM Level B	1.25
U ROOF	
Winter calc.	0.239
IRAM Level A	0.29
IRAM Level B	0.77
Summer calc.	0.235
IRAM Level A	0.19
IRAM Level B	0.48

Table 2: Volumetric G coefficient of thermal losses, calculated and compared to maximum admissible levels according to IRAM standard 11604 (1996)

G calc	1.32 W/m^{3}K
G adm (IRAM)	2.2 W/m^{3}K
Q annual load	
Q = 24 x °D x G cal x V/ 1000	17,000 kWh

6. THE WATER CYCLE

Rainwater is collected from the roof and directed through pipes to a perimeter channel where it flows to a pond in the front garden of the house. There, it is circulated once a day to be oxygenated.

This pond works as an evaporative cooling device. Solar radiation makes water evaporate and that vapour in the air, which comes into the house through the front window, causes a refreshment sensation. It also has a psychological effect of cooling as the falling water is heard.

If there is not enough rainfall, a water pipe will fill the pond.

7. USE OF SOLAR ENERGY

A solar system for heating sanitary water— of our own design— will be installed on the roof to help the conventional gas heater. It will provide 120 l a day.

8. CONCLUSIONS

Insulation materials are very expensive and natural gas for homes is subsidised in Argentina.

Electricity is not as cheap as gas, so it is more important to control inner conditions in summer than in winter. There are no incentives to save energy or incorporate solar techniques. This scenario distorts the importance of energy efficiency and renewable energy in buildings.

The house was designed by the author and is now under construction.

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