A methodology for optimum energy efficiency of a typical residence in Greece

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1. INTRODUCTION

Undeniably the natural environment has great affect to the quality of living in a space. For many years people have been seriously taking under consideration the environmental conditions of each area in the construction of their residences. They were created according to their orientation towards the sun, the way the local winds blow and as a result the buildings had very good energy efficiency.

In our days the role of environment in the manufacture of buildings has been downgraded. In the majority of buildings it is given small, or none importance in the microclimate of the region. This has as a result the consumption of big amount of energy and the need of appliances for cooling and heating.

2. THEORY

The majority of buildings and mainly the residences in Greece are built ignoring the principles of bioclimatic design. This mainly happens because of the ignorance of the advantages of bioclimatic design, the increased cost of manufacture of certain systems and also because of their- small- need for maintenance.

However in our days after the swift increase of oil's price, and its consequences, and the continuously increasing pollution of the environment people have begun to turn into natural methods of cooling and heating the buildings.

For the above reasons this study will focus on a methodology for the improvement of living in a typical residence, built contrary to the principles of bioclimatic design. These systems wont demand usual maintenance and the estimated cost will be low.

Our aim is the utilization of simple systems that will be more easily accepted by the habitants since they will be able to easily understand their operation and how much they can improve the conditions of the atmosphere in the house.

This is the reason why this study is related to passive systems of heating and cooling, systems based on the ventilation and on methods that bring good circulation of cool air inside the building.

Finally it is very important to improve the microclimate round the building too.

3. DESIGN

This research focuses on a residence which was designed in the terms of a course of our 2nd year of study.

3.1 Form and place of building

It is a single floor house, 100 m2 in Rio Patras. The slope of the ground is very steep and the main view faces the north. It should also be pointed that the view of the sea on the north affects the design. This is the reason why there are big openings on the northern side of the house and the basic spaces of house are directed to the north as well. Two actions that are indisputably opposite to the principles of bioclimatic design. Nevertheless the bedrooms are protected on the southern side.

3.2 Constructional elements

The materials that were used for the manufacture of this building are the same ones that were used in the majority of buildings in Greece. It is constituted of reinforced concrete while the

compact elements are made by bricks. The flat loft is also made of reinforced concrete.

3.3 Systems of Heating and Cooling

The study is based on the bioclimatic principles, that are to say on the optimization of solar profits and the restriction of energy's losses. This ensures thermal comfort during the winter and the summer.

The constrains that will be followed is that minimum transformations in the building's structure as well as the smallest possible cost of manufacture and maintenance will be permitted.

This is the reason why passive systems of cooling and heating are used without any changes in the arrangement of spaces.

3.3.1 Systems of Heating

This residence has a major design fault which is contrary to the principles of bioclimatic design. The view of the sea on the north had as result all the main rooms of the house to be placed there, while usually on the north the auxiliary spaces are placed in order to create a thermal protective zone. Nevertheless the bedrooms are protected by a corridor which extends at their length on the north side. The arrangement cannot change because, as it was reported and above, as less as possible transformations in the buildings structure can be allowed. Consequently it is necessary to find ways that will improve the energy consumption of the residence bypassing the above design choice.

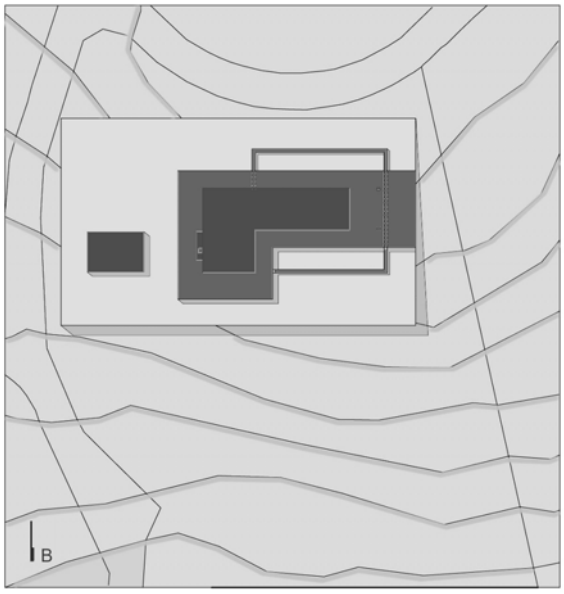

Figure 1: Topographic.

In particular, great attention is given at the heat insulation to ensure the absence of thermal bridges, the points in the insulation where discontinuities are presented in the manufacture or lack of precision at the application. For this reason additional insulation is placed on the exterior side of all compact elements and also on the loft. The glass panels on all sides of building consist of double insulating glasses. Glasses of advanced technology with low emission (low-E) can also be placed, something that rises the construction cost a lot.

On the southern side of the residence there are big openings that allow the sun to enter during the winter. At the floor, which is made by ceramic tiles, a material with big heat capacity, heat from the sun is stored and it is attributed in the house little by little during the day.

In the region where the residence is placed, strong northern winds blow during the year. For the protection of the most private rooms, like bedrooms, from the winds and direct optical contact, a 2m height wall is extended along them. Additional planting and trees in front of these rooms and the lounge protect from winds and also creates a pleasant microclimate around the building (Fig. 2).

Trombe walls on the southern side can also be placed and certain openings on the north to be closed, constructions however that impose big intervention in the building and require dedication of time by the householders (trombe wall) for their right operation and their maintenance.

3.3.2 Systems of Cooling

Thermal comfort is very important in the house during the hot Mediterranean summer.

The methods that were described contribute for the right energy operation of house during the summer too. The insulation that is applied on the walls and on the loft as well as the double glasses, protect the interior of the house from overheating.

The floor plan of house is "open", without obstacles. This means that the conditions are favourable for the free circulation of air in the house, by opening the windows during the summer and creating currents with air that comes from outside, giving a sense of dew in the habitants. The circulation of the air in the

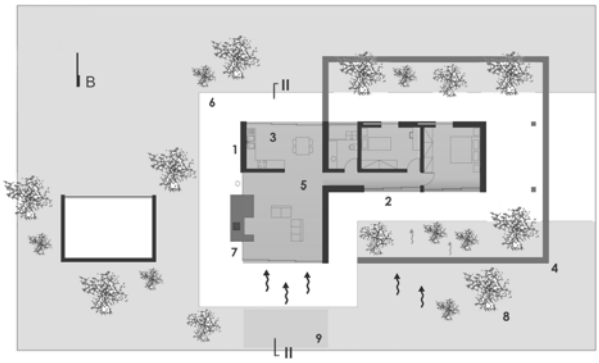

Figure 2: Ground floor plan.


Figure 3: Section II, summer.

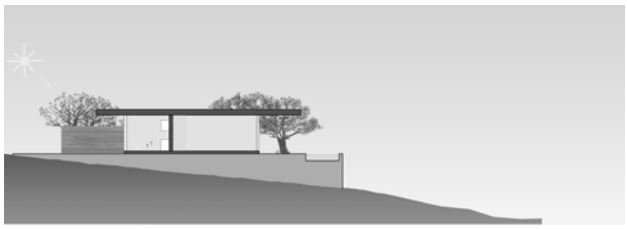
Figure 4: Section II, winter.

1. Exterior insulation in the compact elements.
2. Double insulating glass.
3. Floor made of ceramic tiles with big heat capacity.
4. 2m height wall to prevent from northern winds.
5. Open ground plan for free circulation of air.
6. Horizontal overhangs on the south with proper length to prevent the sun from entering the house during summer and allow it during winter.
7. Vertical fins on the eastern side
8. Trees that protect from strong winds and make shade during summer.
9. Evaporative cooling due to lake's water which is placed at the northern side where strong winds blow.

house can be strengthened by the placement of fan in the roof, which consumes too small amount of energy.

On the southern side of the building horizontal overhangs, that their length is calculated by the formula S = h/tan a (Figs. 3 and 4), prevent the sun from entering the house during the summer, when is high in the sky. On the contrary, in the winter the sun enters freely and warms the house. The openings on the Eastern side are protected from vertical fins which their angle can be adjusted automatically depending on the place of the sun.

Solar elements can optionally be placed at the overhangs that will collect the solar radiation so that it is used for the lighting and the operation of electric appliances of house.

Trees and remaining planting round the house protect it from the cold northern winds during winter and improve, at the same time, the macroclimate and create pleasant shade during the summer.

Walls are necessary light coloured, which have low levels of solar absorption, so that overheating in the interior is avoided.

Finally a small lake in front of the northern side, where strong winds blow during the summer, intensifies cooling due to the evaporation of the lake's water (Fig. 2).

4. BENEFITS

The advantages of this study are the following:

- These solutions are easily feasible, applicable and they can also be applied in the majority of residences in Greece.
- In order all these proposals to be constructed, not essential changes at building's structure, the interior and the exterior of residence are required.
- All systems that are proposed have low cost of manufacture and very small requirements of maintenance from the habitants.
- The functions of these solutions are easy and therefore more easily people take the decision to apply them at their own residences.
- Finally, they are flexible enough to accept other solutions, like the expensive solar panels, to be added in the future.