TORRE GUIL ENVIRONMENTAL EDUCATIONAL CENTRE, MURCIA, SPAIN

Proposal for energy saving and demonstration

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ABSTRACT The buildings of this Environment Educational Center, designed with innovative energy saving features, minimize the impact on the preexisting environment. Renewable energy concepts have been applied to the building design, and intelligent control of lighting and air-conditioning has been included. Most of the buildings are green roof underground buildings, where domes that allow spans up to 42 m have been designed. Average energy saving is over 70% on heating and cooling demands and 60% in lighting. The design optimize the energy savings on underground constructions through several innovative concepts as the use of specific natural materials that act both as insulators and thermal mass or the selective distribution of the thermal mass on building perimeter. The Center will promote the demonstration of rational use of energy and disseminate on environmental protection. The studie of the view was made to integrate architecture and surrounding. From our point of view, "it is necessary to gain knowledge and to cultivate lectures of natural environments from all points of view, including the architect who must be able to adopt a posture of respect towards nature, even when this means you are unable to leave your artistic print at the building site".
This project is financed by The Mediterranean Saving Bank, ***CAM*** *and has approximate cost of 5 900 000 $ ECU or 6 700 000 $ USA, that will be finished the 30th of November 1999 and executed by the constructor* ***VILLEGAS.*** *Murcia.*

1 Introduction

This paper describes an innovative Environmental Education Center located in a European Community priority development area of Murcia, Spain, mainly composed from underground buildings with green roofs. The center is well adapted not only to the local environment but also to the nearly situated natural protected area Majal Blanco. Using renewable energy concepts and rational use of energy, savings over 70% in heating and cooling loads and over 60% in lighting are obtained in design phase. The center includes an optimized integrated management of energy. Almost al materials used on buildings are natural and recyclable. The center is conceived as a didactic center where the same buildings are demonstrations of rational use of energy and of renewable energy concepts. The design improves some traditional local architectural approaches for avoiding climate impact on the building. The plot is irregular, with three elevations, and has an extension of 41 000 m^2.

Plastic interventions in architecture have traditionally been executed a posteriori, as "ornamental additions" intended to aesthetically enhance a functionally viable edifice. Breaking with this tradition, the Torre Guil Educational Center currently under construction highlights the symbiotic nature of the relationship between the functional and the aesthetic within the very process or architectural creation itself, at the same time that is seeks to meet the challenge of establishing a harmony between the man-made an the natural. In this sense, the artistic interventions included in the project are meant to act as a bridge between what may be understood as the architecture of nature on the one hand, and man-made construction, on the other. It is keeping with these ideas that this paper will expound on the three-way dialogue between nature, architecture and sculpture within the ecologically oriented Torre Guil project.

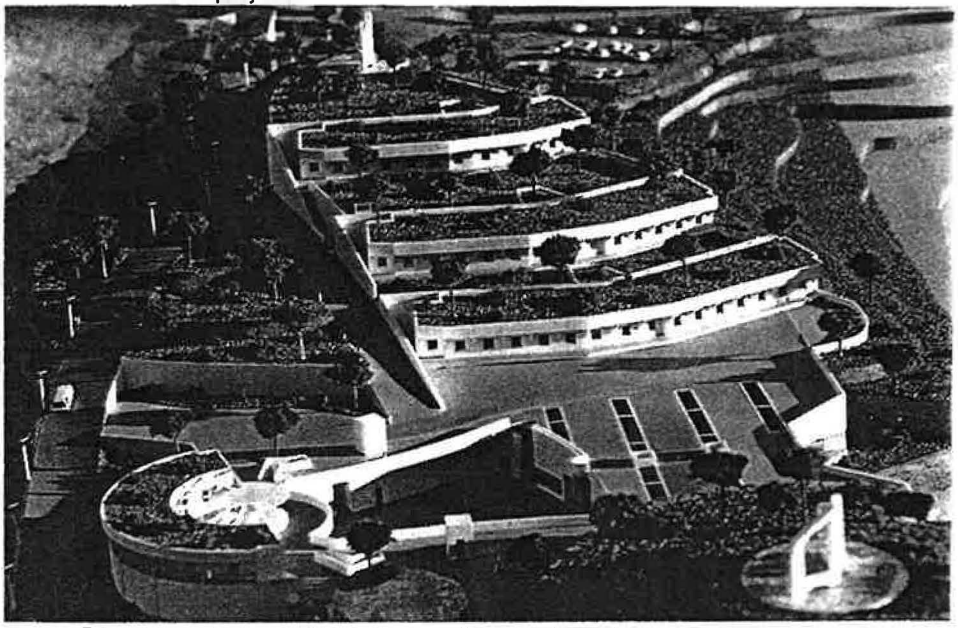

Fig.1 Educative and services (dormitory) pavilions. Scale model.

2 Design guidelines

The hills configure a specific visual and formal relation between each other and the rest of the plot, with a view of the Guadalentin valley. The original forms of orography have been preserved and the constructions have been composed based on these forms. Most of the buildings are under 2~5m of the ground level and the covering of some buildings is the mountain itself.

The climate is very hot in summer, with high average temperatures and very limited rainfall. The east wind prevails in local winds in summer, autumn and spring. In summer the drought lasts for the whole three months. Therefore the design is based on the typology of a popular local architecture of the zone (the underground house) that has been adapted and optimized in the project to maintain thermal comfort levels during the whole year on the Environmental Educational Center (EEC).

Three singular buildings conform a delimited space between two of the hills. The central building (3 085 m^2) includes a hall and classrooms, and an attached patio with a small lake. A pavilion of services with dormitories (1 200 m^2) and a pavilion of services-cafeteria (457 m^2) at each side complete the main buildings. Apart from these buildings, there are two single family houses named "Green House" with advantages of low energy consumption (272 m^2) and another house with passive systems (190 m^2). The design integrates natural ventilation in the architecture. The exterior warm air is cooled by natural evaporation. The prevailing winds are used to increase ventilation. The opened and partially-opened spaces accumulate fresh air. The natural illumination is complemented by low-consumption systems. All the passive elements have been integrated in the constructive architecture or in the pre-existent architecture, the landscape. The domed structural system of conoid type helps the circulation of the hot air by the highest parts of the structure complemented by a chimney system promoting natural ventilation. The structure includes light conducts that takes natural illumination up to the lowest levels of the building. The concave fixed surface allows the diffusion of natural or artificial lighting.

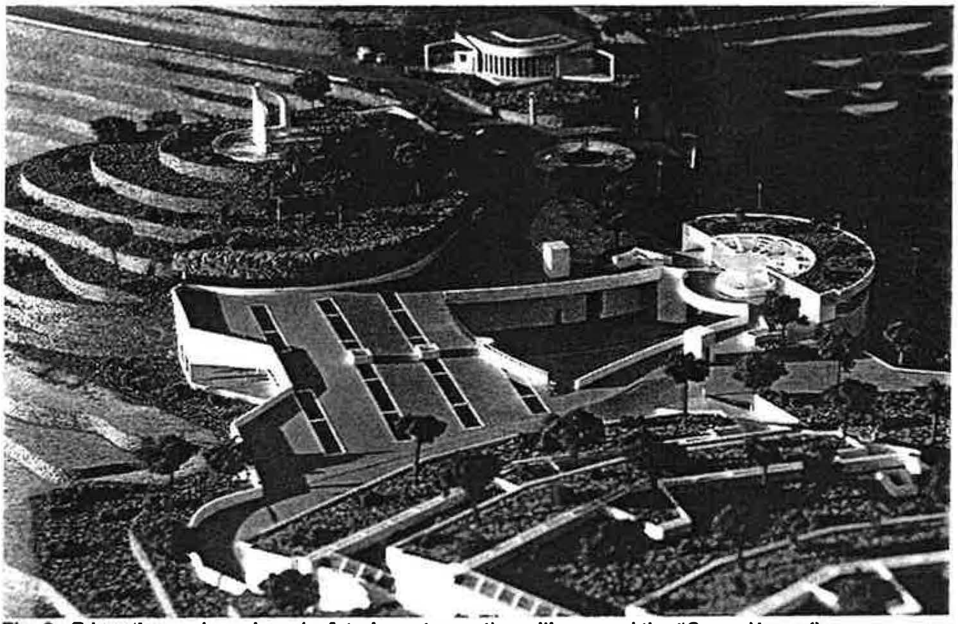

Fig. 2 Educative and services (cafeteria-restaurant) pavilions, and the "Green House"

A domotic bus of communications will control the center: the natural and artificial low energy illumination, spotlights for emergency, natural ventilation, internal distribution of energy, meteorological data logging, control of the solar energy system, monitorization of other installations, and security. The control system makes possible to obtain high luminic efficiency and visual comfort, efficiency of the energy use and reduction of costs. All the residual water is depurated and re-used again, drastically reducing the consumption of water. Materials as the components of destructors to the ozone layer and especially the components of CFCS, HCFC, the isolation of asbestos or similar contamination, the products that are clorafied, solvents, varnishes with toxic continents, heavy metals, wood from forest in the phase of extinction or its exploitation doesn't correspond with the supportive development have been excluded based on ecological reasons.

Table 1 Evaluation of loads and energy savings obtained on the ECC Torre Guil

	heat. annual MWh	cool annual MWh	heat.&cool annual MWh	max. power heat pump kW
Total of energy needs[1], ECC Torre Guil				
Requirement	27 425	29 325	56 751	118 703
Savings	45 382	97 083	142 463	134 108
% savings	62.3%	76.8%	71.5%	53.0%
Electrical energy used on air-conditioning, ECC Torre Guil				
NEEDED[2]	8 570	10 473	19 044	
SAVINGS	14 182	34 673	48 854	

[1] For proposed buildings. % saving relative to the reference building.

[2] Considering a efficiency of 2.8 as cooling - and 3.1 as heating machine for heal pumps.

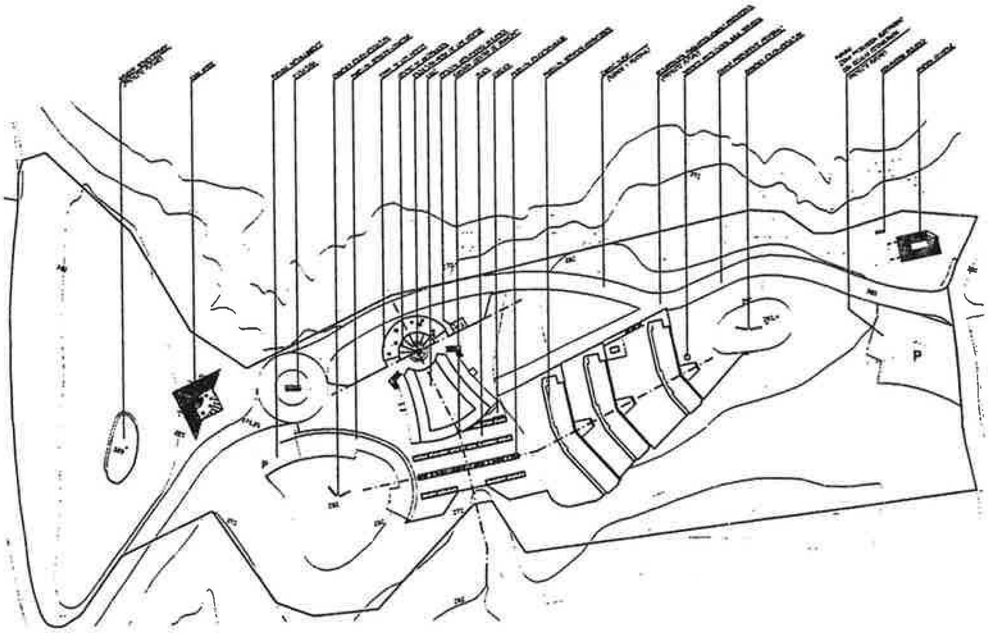

Fig. 3 Plan of the ECC Torre Guil, showing the building adapted to the pre-existent elevations

3 Passive systems

The design of the edification carefully saves a lot of energy consumption; the study of the different systems permits the climatization by natural means and integrated in the architecture; the exterior surrounding due to the semi-burial of the buildings, the entrance of warm air and posteriorly cooled by a natural evaporation system, the utilization of the winds to augment the ventilation, the creation of the opened space and semi-opened like accumulating elements of fresh air, like this the natural illumination systems. But apart from this, the circumstances of the necessities of natural illumination, ventilation and climatization give in general; and they are in some cases compared; this is, the opening of a gap like a window for illumination that comes contra-indicated in the thermal aspect by the entrance of the warm wind of Sirocco; for this, in most cases, the ventilation, the entrance of fresh air or of natural illumination doesn't pass by the same conducts of strategic architectures. For another part, all the passive elements have been considered, integrated in the constructive architecture or in the pre-existent architecture, this is, in the landscape. In the globalise synthesis, it can be affirmed that the fundamental base of the climatization and the exterior surroundings, the entrance of fresh air (from the mountain or its evaporative cycle), the air-radiation of the infra-red spectre during the night, the utilization of the adequate winds (Levante), the protection of the warm winds (Sirocco), combined withal the determined elements, strategically fixed, denominated wind chimneys. In other cases, like the headmasters office, there is a curtain of water and roof ceiling of water integrated in the landscape. The natural illumination is resolved depending on each case, direct illumination, indirect illumination with losses of warmth produced by the tunnel of air (case of class-rooms and assembly hall), direct illumination protected with brise-soleil (case of library) etc....

For another part, also it has been proposed, the utilization of active systems in the production of hot sanitised water and photovoltaic systems for the electronic production. In total, the different systems suggested form an all out group and singular, adapted and rationalised in each case; being susceptible the studying and modelizing to bring the corresponding conclusions.

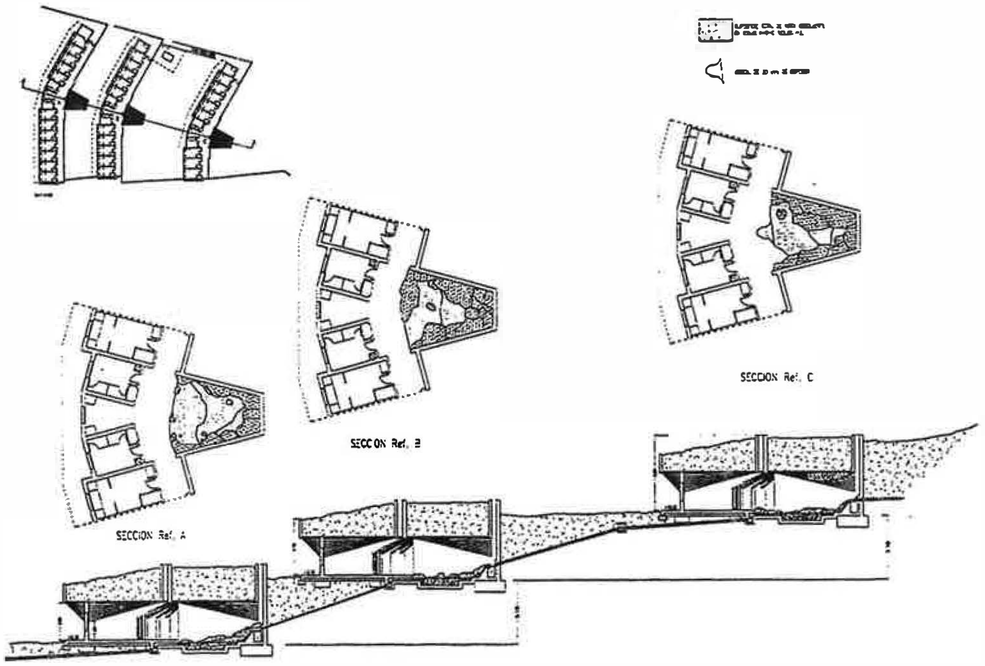

Fig.4 General cross-section showing the green roof integrated on the local natural environment

4 Evaluation of loads and energy savings

The evaluation of energy savings has been performed during the design project using as the start point the original proposal of the architect for the different buildings, and several alternative solutions have been compared using modelling by a thermal evaluation program. A conventional building over ground surface has been used as the reference for the comparison between the different solutions. The improvement of the proposed alternative is measured trough the difference on energy needs relative to reference building. The reference building has identical geometry, use conventional materials for construction and uses the same time-schedules, occupation, meteorological data, has the same orientation and dimensions, obstructions and shadowing as the modelled building. The conventional building is not provided with solar passive systems. No other differences have been introduced to avoid any subjective influence on the analysis. The reference buildings have therefore conventional glazing, conventional walls using light concrete blocks, and conventional internal and external plastering, and standard level isolation (Spanish regulations on isolation). SUNCODE, the PC version of NREL SERIRES thermal evaluation program done by Ecotope, has been used for modelling. SUNCODE has the convenience of providing the source programs, that allow to adapt the code if necessary.

5 Conclusions

A design based on the typology of a popular local architecture of the zone, the underground house, has been adapted and optimized using the latest technological advances allowing for significant energy savings both in heating and cooling needs and in artificial lighting. The design integrates natural ventilation in the architecture, being natural ventilation a fundamental parameter of the energy needs of an underground building. The water is recycled and only natural materials without ecological impact are used on the buildings.

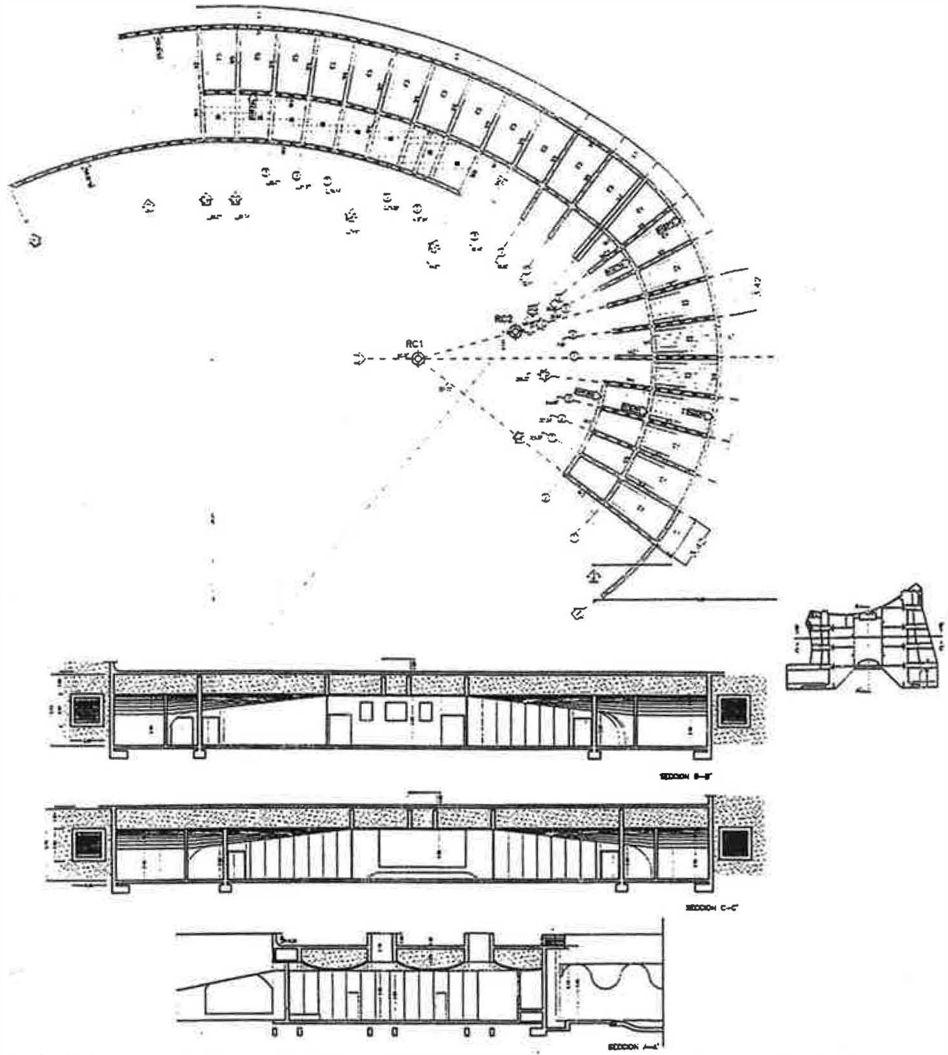

Fig.5 Structural conoid domes that allow spans up to 42 m help the natural convention and sustain the green roof over the underground buildings

The passive elements have been integrated in the architecture and in the landscape. Light conducts allow natural illumination of the lowest levels of the building. Domotic* control of the ECC Torre Guil of natural and artificial illumination, natural ventilation, internal distribution of energy, meteorological data logging, and security systems is provided.

6 References

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* 'Domotic' control (from the Latin domus) is a whole house programmable control system, providing for security, fire detection, heating, cooling, lighting and switching of small appliances, including all sensors and actuators.