The Solarium and the Court-Yard as Climatic Modifiers in Mediterranean Vernacular Architecture

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ABSTRACT

The solarium and the courtyard are fundamental traditional structures of thermal building control, which reflect the wisdom of traditional mediterranean architecture.

This paper will examine the traditional forms of solariums and courtyards of domestic vernacular architecture in Cyprus and will explain how they create appropriate environment through their varied design and the use of natural sources of energy.

Reference will be made to results derived from optimization studies obtained by using microcomputer versions of «SERI-RES» and «5000 Method».

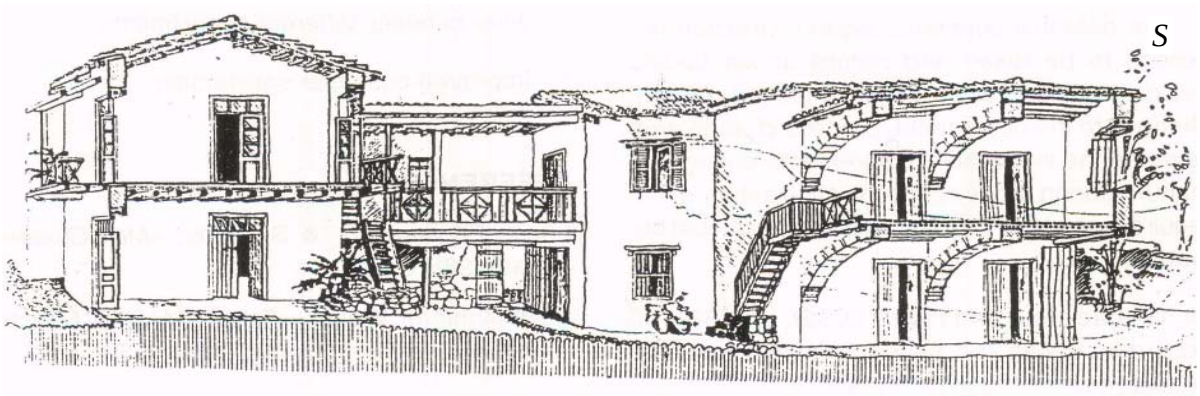
SIGNIFICANCE IN VERNACULAR ARCHITECTURE

In Mediterranean and hot climatic regions where sunshine in winter is desirable and cooling and ventilation in the summer necessary, the solarium and the courtyard are •indispensable solar features of the houses and unique elements of Cypriot vernacular architecture.

Both components, although outdoor, open spaces of the building, they are focal elements around which the various activities of all the other spaces are synthesised whether the house is in the plains, in the mountains, the villages or the cities. They form the heart of the dwelling spatially, socially and environmentally.

They are significant architectural features and early instinctive approach to passive solar design, which acted as climatic modifiers in the Cypriot house. Their arrangement evolved naturally from the climatic conditions, the needs of the family and the social structure of the community.

Always adjoining each other they act as transit spaces and unite the outer with the inner building layout. They are extensions of the house outwards and simultaneously of the

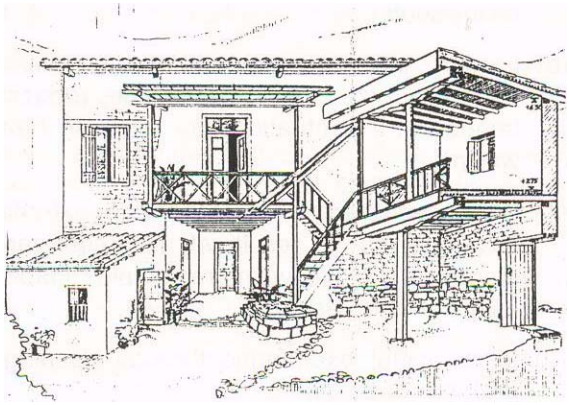


outdoors inwards.

Their form and function vary from region to region even from locality to locality as expressions of their sensitive response to the
various effecting parameters.

USES

The solariums and courtyards have multiple uses in vernacular architecture varying



according to region, locality, climatic conditions and social structure.

a) Functional

(i) Inside House Activities

The solarium, an internal space with its south side open, accommodates the functions of the inner house in the summer and in the sunny winter days:

— Living space:- People spent most of their leisure time in these spaces.

— Cooking, Washing, Eating:- Furnished with an oven, washing basin, some kind of bench or table and an external fire place, it accommodates daily activities such as cooking, washing and eating.

(II) Outside Activities

Also the outside activities are transferred to the solarium when the weather does not allow them to take place in the open air.

— Preparatory Agricultural work:- For the farmers the courtyard is used to handle agricultural products (laying, drying of fruit etc).

(Hi) Privacy

Mostly secluded at the rear of the house, protected with high abode walls or the house volume itself, both components offer privacy to the occupants.

b) Social

(i) Social Contact

When the courtyard and the solarium open on to the road they allow social contact.

(II) Receiving Visitors

Both, the solarium and the courtyard, are used as reception spaces offering pleasant transitional environment from the outside to the inside and at the same time allowing the occupants to retain their privacy.

(Hi) Status

The configuration, size and decor of the components express the social, and financial status of the owners.

c) Aesthetics

When located on the facade of the house they offer decorative potential with the use of the materials, the archades, the gardens and their other constituents.

d) Spatial

The solarium is a predominant architectural feature of the house whether acting as:

(i) A Portio

(ii) An Archaded Corridor

(Hi) A Central Axis or even when it evolved in a

(iv) Self Contained Space

It always provided the house with its focal space even in periods of prosperity when the construction of bigger houses was financially and technically possible.

THE SOLARIUM AND THE COURTYARD AS CLIMATIC MODIFIERS

The solarium and the courtyard, besides their aforementioned functions, are two fundamental means used in traditional building design to temper extreme weather conditions. Combined with their other uses they always create a

microclimate that moderates the climate surrounding the building.

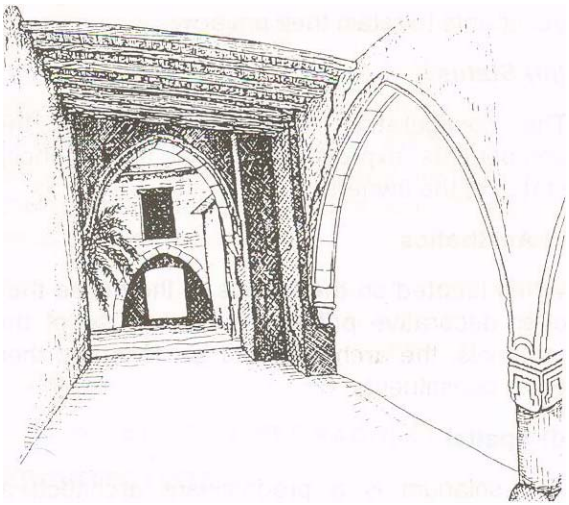
A. WINTER

The design of courtyards and solariums varies according to the degree, frequency and pattern of solar radiation, winds, rain and snow.

a) Solar Access

In old houses the main concern of the courtyard and the solarium was to ensure privacy while also providing good conditions for solar access to the southern elevation.

The configuration of courtyard and solarium form houses are key devices for achieving this aim by providing enclosed private spaces. Also



this geometry of houses makes explicit the intention to provide insulation to different rooms at times when sunshine may be most beneficial.

However the proportions of both components can play a crucial role in solar access.

(I) Courtyard

When the courtyard faces South it acts as sun-space receiving desired solar radiation in winter. The solar access, in «patio» type courtyard, depends on:

— The spacing between buildings (courtyard's width)

— Sun's position at its lowest sun-path

— The height of the building

— From optimization studies carried out with SERI-RES amongst Cypriot houses, with and without courtyards, it was found that introduction of courtyards and south aspecting windows incurs more savings. More specifically a fl-shape courtyard saves more energy in the house than an L-shape one.

These are more complex shapes resulting to additional factors intervening in their thermal behavior leading to their extra heating in the building. Such additional factors are:

a) The more composite internal layout encompassing more spaces and surfaces facing south.

(b) Larger internal thermal mass whose positions, size and distribution reduces temperature fluctuations by retaining heat within it.

(c) Enhanced thermal protection on external envelope as a result of the courtyard morphology of the two more complex shapes especially the fl-shape.

(d) More useful exchanges through openings and surrounding walls.

(ii) Solarium

The extent of the solarium cover admits the rays from the winter sun to penetrate and so solar radiation can be utilized in winter. For this reason the solariums on the mountainous areas move in the upper levels for better winter insulation.

Of course in vernacular architecture the width of projection of the cover varied and it was intuitively sized by the indigenous builders. . .

Nowadays the sizing of the solarium projection and the side walls can be effectively designed to permit solar access in winter with the use of dynamic computer building simulations.

Optimizations SERI-RES studies show that the introduction of the permanent solanum overhang on the fenestration of Cypriot houses, results to a reduction of heating savings only by 8%. This is attributed to the loss of useful solar gains intercepted by the permanent solarium overhangs.

However, the summer shading benefits are exceedingly more to justify the incorporation of solariums of the houses 'facades.

b) Buffer to winds and cold air temperatures

When the courtyard and the solarium are facing towards exposed, vulnerable in winter sides they

act as buffer to the building creating calm corners protected from cold prevailing winds and low air temperatures.

(i) Surrounding Buildings

The surrounding buildings of the courtyard protect it from cold winds; their height however determines the occurrence or not of wind turbulence. If the width of courtyard (W) is smaller than twice the height of surrounding buildings (h) no turbulence occurs.

If W = 2h - 4h Turbulence and down draughts occur.

(ii) Plantation

Vegetation fences in the form of wind breakers, and wind channels, could obstruct the winter winds, or at least reduce their velocity and consequently the heat losses from the building.

Walls and tall dense planting close to the building could screen of, or direct cold winter winds over the building.

B.SUMMER

The courtyard and the solarium form a key issue in building design. In multiple thermal modes and varied design, they moderate high summer temperatures; their careful construction combined with the surrounding landscaping lower the temperatures around the building.

a) Radiation

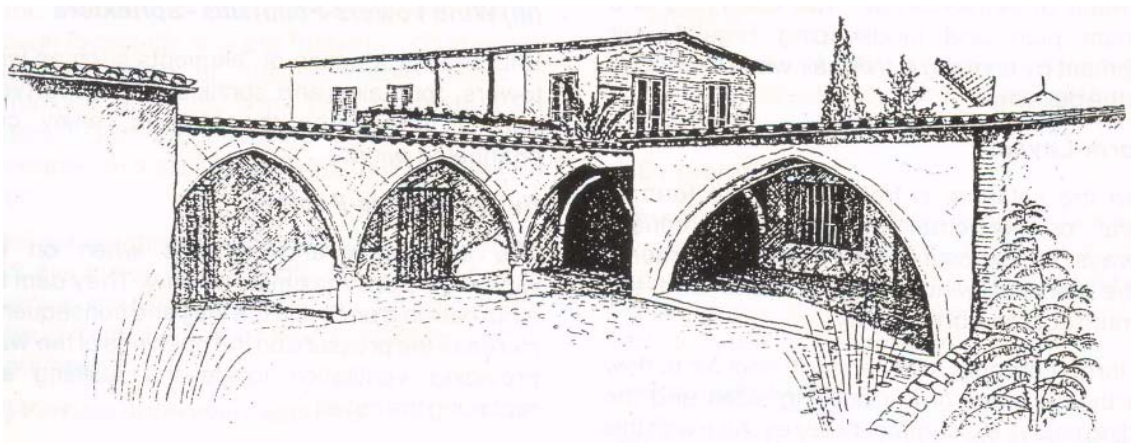
The temperatures in and around the building can be tempered or aggrevated by the design and nature of the surrounding surfaces combined with the night sky radiation. The surfaces exposed to the clear sky cool down by radiation and the air immediately in contact with them also become cooler. ;

(i) Configuration

In the summer the courtyard building configuration is of particular significance for the Mediterranean hot arid regions such as the inland of Cyprus characterised by large diurnal temperature fluctuations (15 to 25 degrees Centigrade) and the potential inherent in the courtyard to act as cold sink by radiating heat, during the night, to the cold sky. The cool air replaces the hot air around the surfaces and the bottom of the yard. This cooling effect lingers during the following day resulting to comfortable ambient air.

(ii)Mass

Furthermore, the additional mass of the courtyard



and the solarium absorbs and stores heat during the day and releases it during the night to the cooler exterior ambient air. The massive construction incurs damping and time lag of the high day temperatures.

b) Ventilation - Winds and Breezes

Ventilation is necessary for indoor comfort and hygiene.

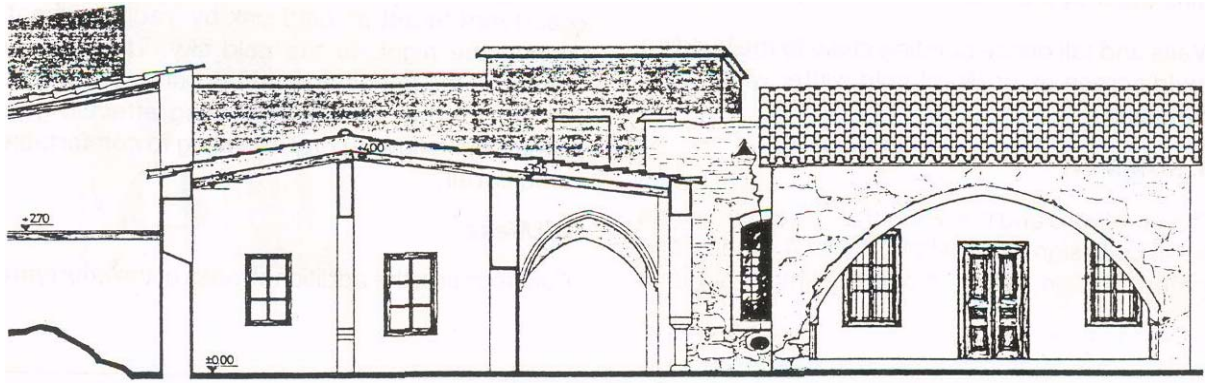
Comfort ventilation is required in buildings even on hot summer days when the outdoor is warmer than the building interior.

In traditional buildings a great deal of attention was given to ventilation especially to the pre-

However, for the efficient functioning of the form and layout, proportions of inlet and outlet areas, their cross-section, wind speeds and direction, and surface mass are necessary to be considered.

(ii) Coastal Areas

At coastal areas the courtyards are positioned at higher level and directed towards the sea breezes. During the day the breezes blow from the sea towards the land; the cool air from the sea replaces the warmer air over the land; as the land reacts quicker to heat than the sea, it heats up during the day from the sun and cools down during the night when the reverse process takes place.



treatment of ventilation air. The courtyard and solarium plan and landscaping regulate air movement by bringing in fresh air when it is cooler than the building.

(i) Form-Layout

When the solarium is designed in the form of central or horizontal corridors and central hallways, the exposure of the sides of the rooms to the passing wind flow increases and the solarium acts as a breezeway.

The large corridors allow enough cool air to flow past the surfaces of the building sides and the building enjoys the summer breezes. Also with this form of layout, the heat accumulated during the day in the walls is removed to the outside cooler spaces during the night. In addition, this arrangement offers the possibilities of window placement for cross-ventilation.

(Hi) Wind Towers-Fountains - Sprinklers

With the introduction of elements such as wind towers, fountains and sprinklers, the courtyard and in furtherance the building, enjoy cool channeled winds.

(iv) Overhangs-Porches

The overhangs and porches when on the windward sides maximize airflow. They dam the air stream in a pocket in the waif and consequently increase the pressure on the openings of the walls providing ventilation inside the building and replacing the hot air.

(v) Vegetation

The vegetation and fences in the form of wind channels increase the velocity of winds by funneling the summer breezes in the courtyards.

c) Shading

The treatment of courtyards and solariums are important techniques in providing shading and in extend for the thermal building control.

The introduction of solarium overhangs and side walls, as solar protection devices, achieves high energy conservation. The unwanted summer solar radiation is intercepted, whilst the desired winter solar gains are almost unaffected, thus reducing considerably the cooling load. From simulation SERI-RES studies on fenestration shading devices this is found to be 37%.

In the simulation studies, the solarium overhangs and side walls are permanent features of the building design; the width of their projection has been defined so that in the summer the solar aperture of the glazing is completely shaded from the high summer sun, while permitting rays from the low winter sun to penetrate and so solar radiation could be utilized.

(i) Enclosing Elements

If the enclosing elements of the courtyard such as the fence wall or the structure of the building itself is higher than its width the walls will enjoy some shading during the day even with the high summer sun.

(ii) Arches and Overhangs

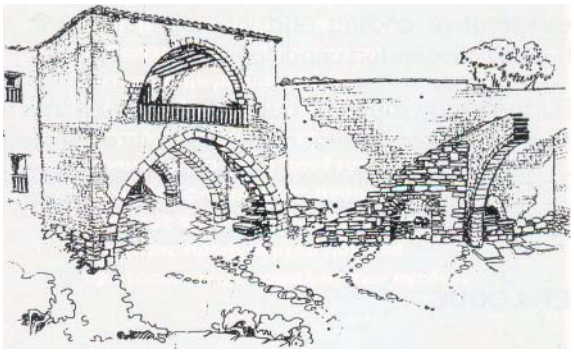
In the form of a porch or when arcaded the solarium provides an effective method of sun-control. The arched arcades at the perimeter of courtyards are indispensable to shield the overhead midday sun. The projection of the roof or the overhang of the solarium is extended far enough to provide shading from the high summer sun. The sizing of the extension varies in vernacular buildings from 1.00 meter to 2.00 meters. Our predecessors over the years developed this sizing intuitively and by trial and error.

From optimization studies carried out with SERI-RES it is found that a width of 1.20m provides effective shading on the south facade of the building from the end of March until the end of September.

(III) Vertical Side-Walls and Fins

In the early summer mornings and late-afternoons, when the sun is very low, the horizontal overhangs are not sufficient to provide shading to the porches and the archaded solariums.

Vertical fins in the form of side walls prevent summer solar radiation from East and West. The efficient sizing of the vertical fins depends on the length of the required shadow, the azimuth of the opening and the period the fin is intended to provide shading. From building simulations the effective extend of the vertical fins is found to range between 1.00 meter to 1.20 meters.



(iv) Vegetation

Shading can also be provided with the introduction of trees and vegetation. The vernacular courtyards, planted mostly with deciduous vegetation like grape-vines, pomegranates, fig trees etc., offer shade in the summer and admit sun in the winter.

- Pergolas or trellises and climbing vegetation are used to shade walls and fences and to reduce the reflected gain.
- Tall trees in South courtyards shade the walls and roofs.
- Dense trees, shrubs, hedges and climbers on East and West courtyards intercept the early morning and late afternoon sun.

d) Evaporation

In the hot arid Mediterranean regions, such as the inland of Cyprus, evaporation for air humidification is necessary for comfort. This is possible by water sprays over the solarium and courtyard walls as well as the vegetation.

(i) Ground Finishings

Natural covers of the courtyard such as grass and plants reduce high summer temperatures and encourage evaporative cooling effect; whereas man-made finishings such as paving increase the air temperature and reduce humidity levels.

(II) Wall Spray-Pipes

Spray-pipes on courtyard wall is an excellent and inexpensive way of providing evaporative cooling in a courtyard. Moreover, spay cools air as well as the wall surface, thereby reducing both ambient and mean temperatures.

(Hi) Fountains, Pools and Sprinklers

In richer old houses the courtyard is furnished with a water fountain which may further provide evaporative cooling and increase the level of humidity to comfort conditions.

Furthermore, the local habit of the inhabitants to sprinkle or throw water on the courtyard floor and vegetation evaporates and cools the air, sets up air convection currents and adds to the humidity.

EPILOGUE

The traditional design of courtyards and solariums embodies very simple and basic concepts of bioclimatic approach, which evolved over many years through a process of trial and error.

However, to achieve fine tuning of these two fundamental components of Mediterranean building design, in order to become successful climatic moderators, it is necessary to develop a deep understanding through scientific comprehension. This approach implies:

- Bioclimatic analysis
- Optimization of their regulatory systems
- Evaluation of their effect on the building performance in search for
- Efficiency and
- -- Cost-effectiveness.

The above considerations necessitate detailed and at same time robust, dynamic and interactive design approach for courtyards and solariums.

This is nowadays possible through modern materials, computer technology and innovative construction techniques. However to ignore the traditional heritage and to disregard the accumulated wisdom of the past is at best ill-informed and at worse arrogant.

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