White in Menorca: energetically sustainable constructive solutions
Construction performance and regulatory requirements

Antonella Violano, Monica Cannaviello
Department of Architecture and Industrial Design
Università degli Studi della Campania “L. Vanvitelli”
Aversa (CE), Italy
antonella.violano@unina2.it, monica.cannaviello@virgilio.it

Abstract—Within the Europe 2020 Strategy about smart, sustainable and inclusive growth, the need to preserve and protect the environment and to promote the efficient use of resources, seems timelier than ever. In this context, the Mediterranean tourism sector tries to follow environmental protection models, which enhance the territorial identity in continuity with the natural and cultural resources, taking inspiration, for example, from living systems proposed vernacular architecture. The Mediterranean island of Menorca offers some interesting examples in terms of sustainable tourism. The picturesque village of Binibeca Vell, designed in the ’70s as a tourist resort, is characterized by efficient technical solutions, especially in terms of control of solar radiation and natural ventilation. The paper illustrates their energy and bioclimatic value.

Keywords- Energy Efficiency, Technological Design, Regulatory Requirements

I. INTRODUCTION

In a global scenario, especially in the European Union where environmental sustainability and energy quality are priorities, the tourism industry should adopt models not only protecting the environment but also sensitive to climate change. The World Tourism Organization (UNWTO) is also going in this direction, with it in recent years having sought to promote the development of responsible and sustainable forms of tourism from an energy point of view. The initiative Hotel Energy Solutions (HES) [4], ad example, provides small-medium sized European hotels an online tool designed to detect energy consumption as well as identify the most appropriate interventions and technologies to ensure a greater efficiency.

Tourism, to be sustainable, should adopt models that are based on local building traditions, in continuity with the natural and cultural resources. For example, taking inspiration from the living systems proposed by Mediterranean vernacular architecture. This is a model that is characterized by the balanced relationship with the surrounding environment. The building is designed and built in order to optimize the relationship with the sun and wind, using different shapes, materials, openings, overhangs in relation to the orientation, and, in particular, in relation to the influence of the climatic and environmental resources on different facades.

In January 2013, local and regional representatives of the EU and the Mediterranean partner countries met at the Committee of the Regions in order to discuss some issues of great interest to the region as well as promote sustainable tourism in the Mediterranean. Some interesting ideas on sustainable tourism come from the island of Menorca, in the heart of the Mediterranean.

II. CONSTRUCTIVE TRADITION IN MENORCA

Menorca, which has an area of about 700 square kilometres, is the second largest island of the Balearic Islands and incredibly rich in history. However, the cultural “signs” left by various dominations are nothing compared to the beauty of the landscape. In fact, nature still appears to be the undisputed master. Even if it is the closest of the four islands to the “mainland”, Menorca has been able protecting its identity, especially against the mass tourism that for decades has invaded the Mediterranean and Spain. This is due to the approach of its inhabitants, who have managed to preserve as much as possible of their environment, along with their cultural identity and traditions. The Menorcans have managed to do something that now seems anachronistic: man who adapts to the environment and not vice versa. This approach has also been used in tourism field, where proposing to the visitor, in a more or less explicit way, a sustainable use model that does not damage the environment. Thus, despite tourism representing one of the primary sources of income for Menorca, the island has managed to avoid being overcome by the tourist industry. It is demonstrated by the simplicity of the road network on the island: a single highway runs through the green of the Mediterranean bush and follows the sand dunes from Ciutadella to Mahón; a few minor roads (Fig. 2) link the different municipalities to the main highway. The most of 60 beaches of the island are accessible only through narrow country lanes, in some cases, dirt tracks, surrounded by stone walls that mark the border with local farms.

1 Both authors contributed equally to this work. Particularly, this paragraph is edited by M. Cannaviello

2 Ed. by M. Cannaviello
Menorca still represents one of the few corners of the Mediterranean that is almost intact, and this has meant that the island was declared a UNESCO Biosphere Reserve in 1993.

Typical Menorcan houses (Fig. 1) have remained the same, for the most part low and plastered in white lime, perfectly integrated into the landscape without creating the visual “disturbance” that can be found on the other Balearic islands such as Mallorca or Ibiza. The relationship that ties the architectural characteristics to the surrounding weather conditions is evident.

The climate on the island of Menorca is typically Mediterranean, with fairly mild temperatures throughout the year, especially from April to October, and a maximum of around 27/28 °C in summer (Fig. 2). It has a low annual rainfall, especially in the south east (450 mm), and slightly more inland and in the northern regions of the island (650 mm). There are about 70/90 days of rain in a year, concentrated in the months of February, April and November, while there are over 300 days of sunshine during the rest of the year. The prevailing winter wind comes from the north, with the island having earned the nickname Isla de Viento, but in the summer months it turns into a nice cool breeze.

When discussing energy sustainable tourism, there is a place on the island that can be appreciated more than the others for the effectiveness of the proposed solutions. It is the picturesque village of Binibeca Vell, located in the coastal area south of the island, about 5 kilometres from the town of San Luis, and about 8 from the capital, Mahón.

Binibeca Vell is not, as it might appear at first sight, a real fishing village, but was designed by the Spanish architect Antonio Synthesis in the 1970s as a tourist resort.

III. FROM THE CONSTRUCTION TRADITION OF THE MEDITERRANEAN SUSTAINABLE ENERGY DESIGN STRATEGIES

El Pueblo de Pescadores di Binibeca Vell is inspired by the design principles of Mediterranean building tradition, not only from a perceptual point of view but also from a bioclimatic one.

The morphological and technological components of Mediterranean architecture have constituted, in this case, the starting point in order to define strategies for a contemporary sustainable energy design.

Analysing the characteristics of the technical architecture, the small holiday resort of Binibeca Vell is evidently designed in order to ensure a natural/passive thermohygrometric comfort, especially in summer.

To reduce unwanted free heat gains, it is necessary to build a dry breathable and well-insulated building envelope, with correct natural ventilation, appropriate ratio of glazing and inadequately shielded transparent components. [1]

The prevailing needs orientating the technological solutions [2] included:
- reduction and displacement over time of the entering heat flow;
- dissipation of accumulated heat.

The first has primarily resulted in strategies for the control of direct solar radiation and the use of building envelopes with a high thermal inertia. While the second is related to the use of natural ventilation and passive cooling (mainly during the night). The design solutions concern both the neighborhood level than that of building. The compactness of the built environment of the village, for example, helps to meet both these needs. The shadowy spaces generated by the narrow alleyways, in fact, allow controlling the direct sunlight during the day and favouring the formation of cooling basins during the night.

At building scale, the control of the direct solar radiation is possible through multiple strategies: in particular, using surface finishes, which are effective in reflecting radiant energy, and favouring the natural ventilation, with an appropriate orientation and size of the windows.

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[3 Ed. by A. Violano]
IV. WHITE ROOFS MINIMIZE THE SOLAR GAIN

In this climatic context, the prevailing need is the “right to shade”. Studying the Pueblo de Pescadores, it is possible to observe some of the design strategies used to control solar gains in the warmer months.

First of all, it is worth noting the use of the colour white, not only for the walls, as usually occurs in other areas in the Mediterranean, but also for the roof tiles. The colour white is, in fact, characterized by a low solar radiation absorption coefficient (about 0.3). This ensures low surface temperatures of opaque components and determines a minimum heat transfer to the interior of the building. In contrast, a conventional roofing made of brick tiles has an absorption coefficient equal to 0.6.

In terms of energy balance, in the evaluation of the solar thermal contribution, we must also consider the exchange for infrared radiation skywards. It must be considered as an increase of transfer of thermal energy transmitted to the envelope and not as a reduction of the solar energy input. The heat, absorbed and not transferred to the atmosphere, causes not only an increase in the internal surface temperature of the component, strongly conditioning the air temperature inside the rooms, and then the comfort, but also a negative influence on the environment, and thus on the "heat island" phenomenon.

Moreover, the problem of surface temperatures is particularly evident in its horizontal structures, where in the summer season, around 12.00 a.m., the intensity of the solar radiation exceeds 600 kcal/h, while in the southern front it is about 180 kcal/h.

The building component that must be better protected from the sun is therefore just the roof.

In order to limit the energy requirements for summer conditioning and to contain the internal room temperatures, as well as reducing, at the urban scale, the warming, in Italy the MD June 26th, 2015 (Attachment 1) provides that the roof structures of the buildings need compulsorily to verify the efficacy (in terms of cost-benefit ratio) of using high solar reflectance materials.

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The Decree assumes that for these materials the solar reflectance value should not be less than 0.65 in the case of flat roofs and 0.30 in the case of pitched roof.

The legislator's goal is therefore to direct the technological design toward cool roof, characterized by high solar reflectance (ability to reflect the incident sunlight) and high thermal emissivity (high emissivity in the infrared). Studies demonstrated that the cool roofs might allow reductions in consumption for cooling and electrical peak loads even up to 70%. In design practice, a cool roof can be obtained by applying to the roof surface a layer of outer surface coating with very light colour, preferably white, and non-metallic materials.

The white tiles of Binibeca are, according to these principles, a highly efficient technology solution from an energy point of view, which also leads to a strong visual impact connoting in a unique way the landscape. In order to ensure adequate thermal comfort it is also necessary to control the solar radiation through the transparent envelope.

The first goal is achieved, in the village of Binibeca Vell, through a proper orientation and size of the openings. [6]

The surface of the windows in fact, is greatly reduced on the fronts east and west, which are more difficult to screen, because the incident solar radiation has a low inclination and is stronger. The larger openings are concentrated on the southern front, effectively protected by different shading systems: sometimes the simple projection of the balconies, sometimes the use of pergolas covered with straw or white tiles, sometimes simple curtains. The extreme variety creates a visual impact of great harmony, reminiscent of the typical examples of spontaneous. (Fig. 5)

V. NATURAL VENTILATION AND PASSIVE COOLING

To satisfy the needs relating to the removal of accumulated heat, design strategies have been used to favour natural ventilation.

The use of passive ventilation systems, as an alternative to mechanical ventilation, not only has a strategic importance but also represents a very important item in the energy balance. It is a very important item in the energy balance; therefore, the integration of passive ventilation systems can be designed with different approaches in relation to the external climatic conditions. [3]

In this village, the natural ventilation becomes a low energy instrument, both to ensure the needed air changes, and to cool buildings. In fact, the ventilation can be used to ensure air quality through the control of both reducing the accumulation of moisture and controlling the temperature. It represents one of the most easily feasible strategies for passively cooling a

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building, because the air movement, mainly through the phenomenon of thermal convection, removes heat to the structures with which it comes in contact.

In order to obtain adequate performance in terms of air changes and/or passive cooling, the ventilation, which takes advantage as physical forcing the effect of the prevailing winds, is often inadequate, particularly for their irregularities.

The correct design of windows, aligned and positioned on opposite sides, allows the activation of natural cross ventilation, which is generally suitable for narrow buildings like this. Providing sufficient fresh air, it is created draughts close to openings, which ensures the flow rates provided by the UNI 10339, in relation to the Crowding Index for the different use destination. Additional design elements, [5] such as internal courtyards, atrium and loggia are necessary (Fig. 5), because they combine cross ventilation and stack effects. Spaces differently shaded determine air motions by convection. As regards the planimetric configuration, the narrow streets not only protect the facades and windows from direct solar radiation, but at the same time favor the wind channeled, making it extremely pleasant to traverse the village even during the hottest hours.

VI. CONCLUSION

The theme of Mediterraneanness, therefore, today as yesterday is a further manifestation of the dialectical relationship between avant-garde and tradition in an effort to heal the breach between the international nature of modern architecture and the preservation of local architectural identity: the genius loci.

The “talking geometry” mentioned by Piacentini in the magazine “Quadrant” is the same “white architecture, full and empty in harmonic proportions” of Biskra in Algeria, Tripoli “White Bride of the Mediterranean”, Menorca, Capri ...

In the Mediterranean home, whether it is on the Spanish, Italian coasts, Greek or North Africa, we can find some constructive characters, constant in form but more often in the function, dictated by climatic conditions that are more or less evenly temperate winters and summers with long hot dry periods:

- Compact volumes, with deep but small openings that look outward to catch prevailing winds protecting from the sun;
- No eaves ledge and rare overhangs consist mostly of stairs, porticos and pergolas;

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• mud-brick, tuff and stone walls, whose main characteristic is to be "local materials";
• tiled roofing on beams of light wood;
• domination of the white colour of the walls and flat roofs and, sometimes, the same streets (in Mykonos like in Menorca).

These unique characteristics of Mediterranean cities, which represent the image of heritage and memory of environmentally valuable sites, can be the starting point for an informed and appropriate testing of innovative technologies that reinterpret the form and function of the characteristic components in an innovative and energy-efficient modern architecture.

Walking through the narrow alleyways (Fig. 4) which are wedged between the white houses and lead onto small flowered squares, with numerous and varied perspectives, gives the impression of being catapulted into a different world, perhaps the past, bringing the desire to savour every metre, allowing the visitor to share in a unique and timeless atmosphere.

REFERENCES