European Scientific Journal March 2015 /SPECIAL/ edition ISSN: 1857 – 7881 (Print) e - ISSN 1857- 7431

BIOCLIMATIC SOLUTIONS IN VERNACULAR ARCHITECTURE: TRANSITION SPACES

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Abstract

The traditional architecture is founded as a defining element of the identity of a region, and its essence should be preserved and conserved by means of maintenance and recovery actions. Thus, the best solutions and proposals for intervention should be looked for but this doesn't imply a back to back innovation and at construction progress. This work includes the description of techniques for maintenance and conservation of bioclimatic solutions found and inventoried in the north of the Iberian Peninsula, with special focus on a unique bioclimatic solution known as Transition Spaces (from the interior to the exterior of the buildings and vice-versa), whose main purpose is to ensure protection from the elements when entering or exiting buildings, to contribute to the improvement of the buildings thermal performance and to create sheltered interior/exterior living spaces. This architectural characteristic is based on the building's solar exposure, predominant winds and geographical and topographic conditions. It is important to recover the historical heritage in a sustainable manner, allowing it to become an engine of development for both urban and small rural centres that exist in the periphery of the bigger cities.

Keywords: Vernacular; bioclimatic; architecture; transition spaces

Introduction

Popular wisdom related to the construction is a huge legacy in the history of vernacular architecture. The culture, history and traditions of the people of each region were continuously portrayed in buildings that are today part of our beautiful landscapes, constituting a heritage that needs to be preserved and appreciated.

The vernacular architecture has developed instinctively bioclimatic concepts that are nowadays scientifically valid. Given the lack of resources, the simplicity combined to the rationality resulted in the application of techniques and solutions which, although rudimentary, maximize the use of materials and available energy. The adaptation to local environmental conditions implied that buildings have assumed an identity that characterizes the architectural image of each region.

The use of basic local materials like wood, earth and stone has evolved to more complex solutions built with huge negative impacts on the environment. In recent decades, the sustainable construction concept has been developed based on the principles of recycling and maximizing resources, protecting and stimulating the creation of healthy environment leading to the reduction of the environmental impact of the construction sector. In order to support the agents in the construction sector, research projects and knowledge transmission have been developed on sustainable development construction.

This work is part of the BIOURB project, a cross-border project between Portugal and Spain, which intended to contribute to the change of the current constructive model towards a more sustainable bioclimatic model, both environmentally and economically, reducing the energy consumption of buildings and raising the value of bioclimatic heritage along the border. In order to achieve the studies objectives, a survey has previously been conducted on the bioclimatic solutions along the border, more specifically between the areas covered by the municipalities of Bragança, Miranda do Douro, Vimioso, Mogadouro, Salamanca, Zamora and, in particular, areas of the natural park of "Los Arribes del Duero" and "El Sayago"[1].

Main Text

Identification and description of the bioclimatic solutions found in the region

In the context of the assessment of regional bioclimatic solutions, the most prevalent were identified: inertia wall, gable roof, transition oriented spaces, geothermal energy, green roof, evaporative cooling process, and sunspace.

All of the above bioclimatic solutions were described in a previously published paper [1]. Current work is dedicated to the transition oriented spaces (Figure 1) solution which is based on seizing the optimal use of solar incident radiation. On winter solar radiation is used to heat the building’s envelop inertia walls and the glass surfaces (that act like thermal energy conductors), situation that is inverted on the hot seasons when solar incident

energy is not wanted and solar radiation gain is to be minimized, particularly on the glass surfaces.

Figure 1. Transition oriented spaces from the cross-border region.

To prevent solar exposure radiation from heating the glass surfaces and the inertia stone walls (which have widths between 60cm to 1,40m) there are several architectural construction techniques used such as sheds, occlusion devices (shutters) and trees or other types of vegetation. Transition oriented spaces as balconies, porches, arcades and others offer shelter from the meteorological elements when entering or exiting a building, offering "in between" multi-use livable spaces that are the heart of the settlement's social interactions (Figure 2).

Figure 2. Transition oriented spaces examples.

The constructive system

The transition oriented spaces constructive system is normally based on local stone vertical elements that have high resistance to compression loads) and wood horizontal elements that have good behavior in bending imposed by horizontal loads such as wind, snow and the constructive elements self-weight.

These constructive elements roofing structure most frequently consists on a two-level or three-level frame of wooden beams with increasing cross-section area from level to level. The space between the wooden beams decreases from one level to another so that the ceramic tiles fit on the last level in a matter that avoids being taken away by the wind. They are frequently topped with ceramic roofing tiles (that prevent water for

entering and damaging de wooden structures) with internal wood finishing or unlined.

In what concerns the maintenance of these elements, the verification and substitution of damaged ceramic tiles is the most important aspect to consider. Also, painting the ceramic tiles with waterproof paint can be considered to provide roofing tight protection against water and to make them water resistant.

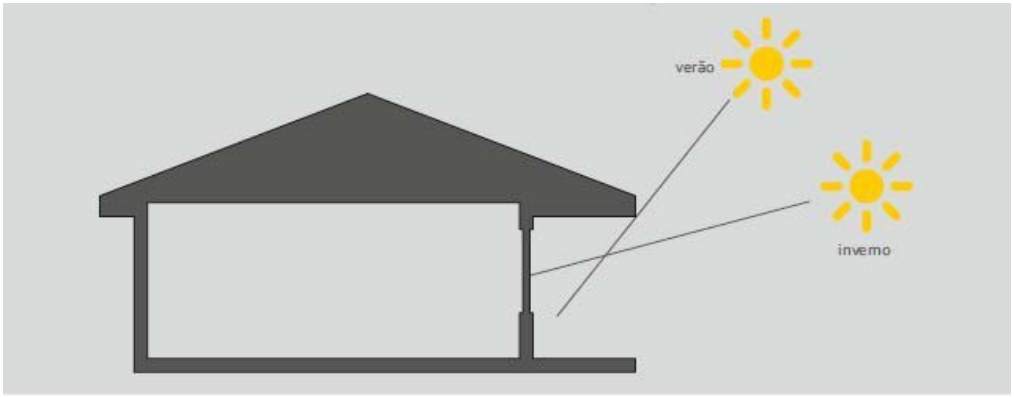
When placed on the street level transition spaces provide shelter from wind, rain or snow and when on higher levels they serve as display cabins for “street seeing” and are commonly used when religious events happen or when the village fiestas are celebrated. On summer, these spaces offer a cooler exterior sheltered space where people gather around on the end of the day. Balconies (Figure 3) are an important architectural element as they are responsible for the horizontal distribution, working as an internal/external distribution corridor. Two storey buildings often have no interior stairs which means both horizontal and vertical building’s distribution is made throughout the interior/exterior balconies.

Figure 3. Balcony/horizontal distribution.

Passive solar constructive solution

An efficient integration of transition spaces on the building's envelope implies understanding annual and daily solar incident radiation variation caused by the sun's journey. Flaps, overhanging eaves, porches, galleries and the balconies roofs, among other transition spaces, should all take part on the building's shading strategy from the beginning of the design process, optimizing the window opening's size, configuration and orientation, providing them with movable shutters according to the building's heating or cooling necessities. The implementation site is also an important factor as neighbor existing or future buildings, topographical conditions, retaining walls or even vegetal growing elements such as trees can over time change the shading conditions of the building which will, therefore, change its energetic performance and its interior comfort conditions.

Transition oriented spaces are often strategically placed on the building's south façade in other to take advantage of solar incident radiation all over the year (Figure 4). On winter, when the sun's angle is lower, solar radiation hits the inertia walls and the glass windows, providing heat and light to interior spaces. When compared to modern buildings vernacular architecture buildings have very few wall openings, interior natural lightning which results on very little daily temperature increase due to solar incident radiation. This means that on summer traditional constructions have little solar gains during the day, reducing the building's cooling needs. The shade on walls and window openings provided by transition oriented spaces on summer, when the sun is placed on a higher position, also contributes to the minimization of solar gains and, therefore, the building's cooling needs.



summer
winter

Figure 4.Transition oriented spaces and solar position over the year.

On summer, window openings placed on the East quadrant (in the morning) and on the West quadrant (in the end of the afternoon) will receive almost perpendicular solar beams that will transmit a high thermal load to these openings. In other to avoid overheating, vertical flaps are a good solution, especially on the west-oriented elements shading.

This kind of spaces takes advantage of the thermal inertia of the walls and its configuration (being the transition spaces most common configurations I, L or U) that protects the users from the winds, harsh frosts and from the large daily temperature variations frequently felt in the region under study. When designing transition spaces dominant winds should be taken in consideration in other to provide shelter from the cold autumn and winter winds.

The traditional architecture: an inspiration for the future

Traditional architecture compiles a long term over the decades trial and error process that optimized the use of local material resources such as stone, earth or wood, but also "immaterial" resources as geographical orientation, deployment site, climate conditions, and deciduous vegetation, among others. This grandpa-to-father-to-son knowledge passed from one generation to another is of great value and consists on a valuable cultural and technical heritage that has great potential either on a rehabilitation or new construction scenario.

Today's buildings are getting more and more airproof because of the quest for enhancing thermal interior comfort imposed by energy efficiency regulations and by tenant's will and environmental conscience. Although they enter on the building energy performance calculations, interior/exterior spaces are often left out of the picture as they are a source of non-heated or cooled air which increases or decreases the interior spaces temperature and are considered second class areas in what concerns prize/square meter. On the other hand fresh air renewal is mandatory concerning interior air quality which is, in new buildings, often made mechanically using central air-conditioning systems and for that, are a source of respiratory diseases.

The building's ecological footprint is related to its non-renewable energy consumption and with the balance between renewable and non-renewable energy consumption, pointing architects and engineers to solutions based on passive energy solutions when designing a building.

Conclusion

The use of transition oriented spaces is very common on vernacular architecture of the northeast cross-border between Portugal and Spain region and it is one of the most important architectural characteristic of this traditional buildings. Its major goal is to provide a "thermal buffer" within

the interior-exterior and exterior-interior transitions, improving the buildings thermal performances and the interior thermal comfort conditions. In what concerns the drawing process, balconies, porches, sheds and other similar solutions should be south geographically oriented in order to take advantage from the sun position either on the could seasons and on the hot seasons (on behalf of the diurnal and annual variation of solar incident radiation).

Other important aspect of transition oriented spaces respects the extension of the building from the interior to the exterior that these architectural elements offer and the social interaction between neighbors and with the passing by inhabitants.

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