Comparison of Architectural Sustainability Models

Solutions analysis for the case “Casas em Melides”

Extended Abstract

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ABSTRACT

In the great human universe, there are professions where its specificity has a bigger impact on the ongoing search for sustainability and resources management. The architecture, and consequently the architects, have a key role and of utmost importance in addressing this central question: will we continue to explore, without weight or measure, the resources that we have at our disposal? Increasingly, social consciousness is structured to respond "no" to this question, and architecture has been able to reply, in certain cases, in a very positive way to reduce the environmental impact of buildings.

The choices made in the different project phases have consequences on the final result of the object, as well as on the overall energy performance and environmental impact that will be caused. In that sense, this dissertation addresses the subject "Comparison of Architectural Sustainability Models", applying the acquired knowledge in a practical case, intending to bring the work as close to reality as possible. Limiting the study to the world of single-family dwellings, being aware that these are not the ones that cause the most impact on the built environment, it aims to acquire knowledge to improve the energy performance of "Casas em Melides".

Based on the concepts of Bioclimatic Architecture, Passive House, Nearly Zero-Energy Building, Bioconstruction, and Permaculture, analyzing four study cases, I intervened on the "Casas em Melides", improving its energy performance. Although the focus of the dissertation is the models of sustainability, as the role of architecture is to combine all the factors that contribute to a given architectural design, aesthetics, function, and material are not overlooked in the proposed intervention.

The work focused then on gathering the necessary knowledge, also based on the study cases, to propose a project amendment to the practical case, as well as the inclusion of various measures that improve its energy performance. Comparing with the initial situation, I tried to analyze the impact of those measures on the performance, which aspects have evolved, which remained the same, and the role and influence of energy assessment system LiderA in the outcome.

Keywords: Sustainability; Environmental Performance; Single-family housing; Resources; LiderA

CONTEXT AND FRAMEWORK

"Our biggest challenge in the new century is to take the idea that seems abstract - sustainable development – and make it also a daily reality for all people in the world." (Annan, 2001) The few years of the new century that passed since this statement was made, confirmed the challenge Kofi Annan divined to be the big problem of the twenty-first century. Although for some, the concern for the environment goes through recycling, by cutting down fewer trees and reducing the emission of polluting gases into the atmosphere, the problem at hand is much bigger than most aware. It must be changed, more than certain habits, all the consumerist and materialistic mentality that has been passed in recent decades by contemporary society. Sustainability is the human response that corrects the way we relate to the environment around us.

While it is necessary that sustainable development encompasses all human activity, it's in the construction sector that a radical change in public practice, in order to achieve a high energy efficiency level, has more importance. This is because the way we build carries much of the environmental pressures that currently the planet is subject to. The role of

buildings and infrastructure is essential, not only because they affect the way we live, but because they also possess the ability to influence several generations due to its long lifetime. However, it is even more urgent to realize that its environmental impact must be reduced imperatively, not only during the construction phase but also during operation and maintenance.

The challenge is then to reflect on the architectural solutions for sustainable construction, but also relate them to the process of designing, assuming its ultimate consequence in the architectural object. This final object is to respond successfully to the environmental issues mentioned above, but also to the aesthetic and spatial architectural issues, in a positive way. The solutions can be integrated into the urban environment, or appear isolated in rural areas, like the case shown in the image below.

Figure 1 – Folkecenter Skibstedfjord building

http://www.folkecenter.net/gb/news/world/earthship/

ARCHITECTURAL SUSTAINABILITY APPROACHES - Concepts

To better understand the various approaches to sustainable architecture we must first study some concepts that classify the goals to achieve when you want to build in a sustainable manner:

Bioclimatic Architecture

This concept holds that architecture must, "since its inception, approach the climate as an important variable in the design process, revealing the sun, in its interaction with the building, for a key role for the same" (Gonçalves and Graça, 2004). This concern results in a series of rules and principles which "seek to understand what climate variables exist on the site (sun, wind, water) and how they can interact positively, with the building providing adequate thermal comfort conditions." (Gonçalves and Graça, 2004).

Passive House

The purely functional definition of Passive House is as follows: "A Passive House is a building, for which the thermal comfort is achieved only by reheating or cooling the mass of air captured from the outside, thus guaranteeing the quality of indoor air, without the need for additional air recirculation." (Dr. Wolfgang Feist, wikipedia.com) Succinctly, it intends to ensure that the building is equipped with passive systems that allow maintenance of indoor air quality, without having to resort to mechanical devices. It can be so achieved a very low energy consumption, which is the main objective of this concept.

NZEB – Nearly Zero-Energy Buildings

A Nearly-Zero Energy Building is a building that produces energy from renewable sources, in sufficient quantity to cancel both the cost of purchased power network (through low power consumption and the amount it sells back to the network), but also CO_2 emissions resulting from the energy produced by the building.

Bioconstruction

This concept is based mainly on the ecological concern of the buildings, from its construction to its occupation. Sustainability is then required in all aspects, giving special importance to the materials used which must come from the local vicinity where it will be built. It is also taken into account the sustainability of the raw material itself, for example, wood, which if it is withdrawn all from the same forest, it disappears there is no wood for future generations to build their homes.

Permaculture

The term Permaculture means: "integrated system of perennial plant and animal species or that perpetuates naturally and are useful to humans" (Holgren, 2002). Being a very broad concept, it focuses in seven fields of application: economics and finance, health and wellness, culture and education, tools and technology, land tenure and community, land and nature use, and built space. The latter field is one in which permaculture influences architecture, being something more conceptual compared with the concepts mentioned above.

STUDY CASES - High Environmental Performance Homes

The architectural solutions that help to reach a certain level of energy efficiency in construction are varied. The focus of the study cases were single-family residential buildings since this will be the object of application and development of the subject studied in this thesis. The selected buildings are located all in Portugal, enabling a direct and personal interaction with them, being a personal conviction that we, (future) portuguese architects must be aware of the quality of the work produced in our country and also the one that, although developed outside our borders, is of Portuguese authorship.

Passive Houses, Ílhavo

This first case study is the first two detached houses to be built in Portugal with the Passive House certificate. It is a good example of how to apply maximum measures in order to meet a very specific concept of sustainability. It shows that it is possible, provided it is done a plan to be followed certain assumptions and maintained the values defined at the beginning.

Figure 2 – Passive House, ílhavo, south view
http://sol.sapo.pt/noticia/77931/Casas-que-poupam-75-de-energia

Figure 3 – east view of the Casa Godiva, from the garden
http://www.archdaily.com/317547/godiva-house-empty-space-architecture

Casa Godiva, Cascais

The second case study to present was recognized in 2012 with the Green Dot Award Prize. Besides being a sustainable architecture reference case, it stands out by the unusual program, given the physical needs of the user. Like the previous case, this shows the same environmental concern, differentiating itself by an aesthetic and materialization more contemporary, showing that it is possible to reconcile sustainability and contemporary.

Hotel Rio do Prado, Óbidos

This hotel stands out for its strong sustainable approach throughout all phases of the project, and its consistent and coherent application in all fronts of use of the building. Being over fifty measures implemented in the project, they are grouped into seven axes of sustainability: energy, water, waste, mobility, environmental awareness, eco-design and low-carbon agriculture.

Figure 4 - view of the apartments of the Hotel Rio do Prado with the surrounding garden
http://riodoprado.pt/

Earthship

Mike Reynolds coined the term Earthship to denote the buildings created by him: “Earthship is the essence of design and sustainable construction.” (adapted from http://earthship.com/, 2016) The main feature that makes this concept totally innovative is the used materials: used tires placed in vats (used in the construction of structural walls), used aluminum cans and glass bottles (used in the construction of partition walls). In addition to the materials used and the construction method, what distinguishes it is the systems that are part of the construction, allowing it to run completely independently of the public supply network. The goal is that each house can produce what is needed to allow living of its inhabitants: energy, potable water, food and thermal comfort. The diagram below shows how they are incorporated in the building:

Figure 5 - synthesis scheme of the elements of the several systems incorporated in an earthship
http://www.sustentator.com/blog-prueba/tags/construccion-natural-en-tierra/

CASAS EM MELIDES – Current State

The case for the practical application of the previous study was chosen for two reasons: for the personal connection I have with the same, and the need of improvements in terms of thermal comfort. The *Casas em Melides*, not being exactly its "name", they received it since they are located in Melides parish, in Grândola municipality. Despite being inserted in the parish, the lot is located, more specifically, in the *Serra de Grândola*, a little outside the village center (2.0 km approximately). The houses, with an area of deployment of 97m^2 each, are inserted in a plot of 10.470m^2. The project arose from the owner’s will to have a relatively simple holiday home, which construction had no greater thermal concerns, come to be inhabited mainly in the summer.

Figura 6 – south view of the Casas em Melides (left); aerial view of the Casas em Melides (right)

The exterior walls are double walls, with an air-box of 3cm between the two cloths and 3cm of thermal insulation. The roof is tilted, built on a concrete slab on which the tiles are directly based. The windows, with a single glass, have aluminum frames without a thermal break. There is no energy production system from a renewable source.

Figura 7 – floor plan of the Casas em Melides

Evaluated the forty-three criteria of the LiderA system, the houses achieved a **level A rating**, representing a factor 2 improvement over the common practice. Not being a negative result, it is not at all a result that reflects a relevant sustainable and environmental concern, by the case presented.

CASAS EM MELIDES – Proposta de alteração

The practical case presented in the previous section has some features that make it a bit simple, mainly the dimensions of the spaces that make it up. Therefore, the current owner of the houses wants to increase the building area, eliminating the space between the two houses, thereby resulting a single volume. Maintaining, however, two separate houses with independent access. To better understand the proposed changes, I now present the red and yellow blueprints, demonstrating what will be newly built (red) and what will be demolished (yellow):

Figure 8 – red and yellow blueprints of the ground floor

With the amendment proposal, it was able to achieve the following objectives in functional terms: ground floor with full access for disabled people; increased kitchen area; the similarity between the total area of the houses; adaptation of the entire upper floor to a room area, and the creation of an independent eating area.

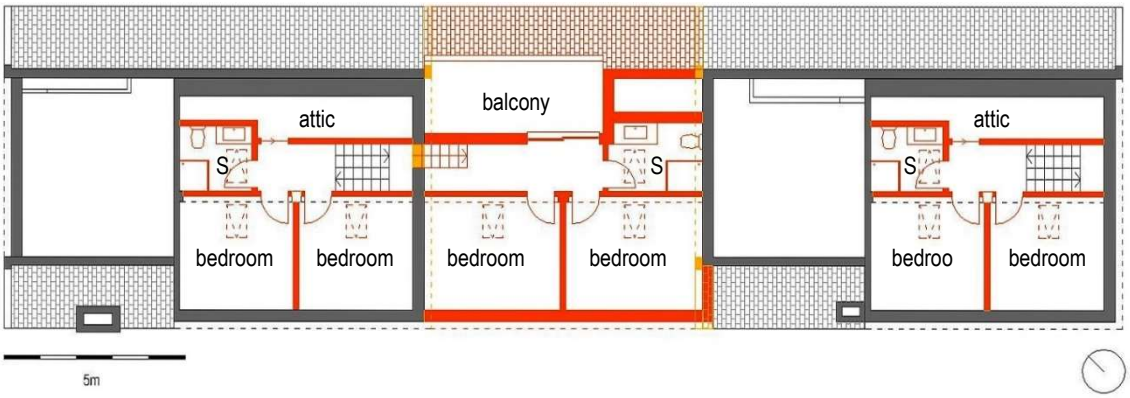

Figure 9 – red and yellow blueprints of the first floor

CASAS EM MELIDES – Improving the energy performance

Striving for sustainability should not be limited to the implementation of individual measures, but it must follow concepts that guide and consolidate the proposal. It should be noted then that, more that adding a set of measures, the proposed amendment to the *Casas em Melides* intends to focus and express specific concerns and sustainable principles, based on the concepts presented earlier:

1. GETTING THE BEST OF THE PRE-EXISTENCE – know to take advantage of what already exists in order to reduce costs;
2. IMPROVE THE LIVING OF SPACES – improve thermal comfort in indoor spaces;
3. INTERACT WITH THE SURROUNDING ENVIRONMENT – positively contribute to the surroundings;
4. INDEPENDENCE OF RESOURCES – low resource consumption and local production of the same;
5. REDUCED COST ON THE IMPLEMENTATION – look for low-cost solutions or solutions that can represent a long-term investment, enabling to down the initial cost, in the future;
6. MONETIZE SYSTEMS – the implemented systems must allow to financially monetize the lot, representing their existence as an asset rather than a burden.

There are described now, very briefly, the constructive solutions, the systems and equipment implemented, which will cause the improvement of the energy performance:

- Improved heat transfer coefficient of the surroundings, through the ETIC System ETICS (External Thermal Insulation Composite Systems) on the exterior walls, and by placing an additional layer of XPS (extruded polystyrene), from the inside, on the rooftop;
- Replacement of the windows for an equivalent in size and design, but double-glazed with an air-box of 6mm, with PVC frames with thermal break;
- Construction of an annex building for agricultural support, henhouse, composting site and recycling center, using construction techniques and materials similar to that of an Earthship;
- Production of food through the cultivation of fruit trees, vegetables, and herbs, as well as raising chickens, providing meat and eggs;
- Collection and treatment of rainwater on the roof for reuse in irrigation and toilet flushing;
- Treatment, in a biological tank and reactor, of waste water (brown and gray), for reuse in irrigation;
- Recycling and composting of waste produced;
- Increase of the outer illuminated area and the incorporation of a fire detection system in the kitchen;
- Energy production from renewable sources: photovoltaic panels and wind turbine (electricity) and solar thermal vacuum tubes panels (water heating);
- Low power equipment: LED lightning and class A energy appliances (50% reduction of consumption);
- Flow reducers inclusion in all taps (50% reduction of consumption);
- Check compliance with ISO 14001: 2015 standard through the ISO14001:2015 Environmental Management System certified by SGS.

Reevaluating the global energetic performance

The combination of all the measures described above, allows the overall proposal to achieve the energy performance class C, calculated according to the spreadsheet of REH. Reassessing the proposal, for the forty-three credits of the LiderA system, it was possible to improve nineteen compared to the initial state. At the end, eighteen reached the A^{++} classification, reaching the criteria related to the Socio-economic aspects a very low rating, due to the rural character of the environment where the homes stand. In the overall reassessment of the energy performance, according to the LiderA system, the proposal achieved the **level A^{+} classification**.

Although not very significant, this rating represents an improvement of the performance of the housing relative to the initial state. LiderA indicates a result of 56,65% on the overall performance of the proposal, against the 29,20% obtained in the initial phase. It is reasonable to conclude then that it achieved a performance nearly twice compared to the initial one.

RESULTS AND CONCLUSIONS

The first objective of this dissertation, on improving the energy performance of the practical case has been fulfilled, since there was an improvement in the overall assessment, according to the LiderA system, by one class (A to A^+) between the initial situation and the proposal. The second objective, relating to the quality of architectural solution at the aesthetic and visual level, as well as the level of quality of user-lived spaces, it was also fulfilled, since the resulting spaces are unequivocally broader and in number, allowing the houses to be lived in a more comfortable way.

The making of this dissertation allowed me to understand, in a way, what are the challenges associated with the implementation of measures aimed at a sustainable concern, in the process of creation of an amendment to an existing case. Every project has inherent constraints of different natures, as each one exists in a different surrounding, each has a specific client, each has different assumptions. Following this reasoning, I do not see sustainability as an asset or an obstacle to the creative process, but just another factor that brings with it conditions that will influence the design of it in a certain way.

Despite having already dealt with the LiderA system in other academic works previously made, the realization of this dissertation allowed me to explore more thoroughly and in detail, its chances, realize its limitations and understand what are its key points. LiderA's application, at an early stage of design, will allow, with all available information, to predict the energy performance of the building concerned. Thus enabling to readjust it in the desired direction: develop some aspect related to a specific area, or improve its overall performance.

That's why my recommendation is, beyond the knowledge that all stakeholders in the construction area should have, to enable a common and cross-cut sustainable concern, that the LiderA system should be included in any architectural design, since its initial phase. Another detail that I think is important to note is the fact that its evaluation doesn't have to be the same for all phases and projects: for example, the practical case was evaluated in more detail than the study cases. This is another aspect that demonstrates the potential of the LiderA system.

"In the sustainable construction, the project base is no longer just the time spent and costs associated, passing to equate also the consumption of resources, the environmental impact, the quality of the built environment and economic and socio-cultural conditions of the project." (Amado, 2015)

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