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FAÇADE REFURBISHMENT AND ITS ENERGETIC CONTRIBUTION

CASE STUDY OF A HOTEL BUILDING IN LISBON

EXTENDED ABSTRACT

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INTRODUCTION TO THE STUDY

The façade serves as the interface between the interior and the exterior space. Among its main characteristics, there is one whose importance is rising due to the environmental and economic situation: its thermal behavior.

Thereby, it is important to study the façade's thermal behavior (according to the current legislation) and the benefits of its possible refurbishment, like the energetic performance improvement, the reduction of the energetic cost, as well as the exterior appearance upgrade.

The aim of the present dissertation is to study the different constructive solutions appropriate for the building under focus– *Amazónia Lisboa Hotel*. Therefore, it also investigates the challenges of the refurbishment process in the accommodation sector and approaches the architectural responsibility for the compatibility of the energetic performance and the exterior appearance.

The analysis intends to compare the different possible solutions, in order to enable the owner of the Hotel to make the decision according to his highest needs and priorities.

The study was based on the relationship of architecture to the climate, solar orientation, as well as to the building use type. It focused the façade refurbishments ability to minimize the energy demands through the architectural design, including passive systems. The analysis of the existing solution characteristics, along with the determination of the objectives and limitations of an intervention of refurbishment, allowed the outline of the possible solutions to be implemented in *Amazonia Lisboa Hotel*.

With the energetic efficiency improvement being the purpose of this study, the main subject of the dissertation is the reduction of the energy consumption in buildings, particularly as result of the façade refurbishment and its constructive elements thermal properties.

Finally, the analysis results verified the energetic benefits resulting from the façades refurbishment, as well as the economic implications and the exterior appearance of each architectural solution.

THEMATIC FRAMEWORK

The green agenda is one of the most important issues of the day. The current consumption and production patterns are not sustainable. Globally speaking, the extraction of natural resources surpasses our planet's supply, leading to an economic, social and environmental threat: the climate change.

The state members of the United Nations (UN), as well as other governments in the world, are making efforts to halt and mitigate the catastrophic effects of climate change, by creating programs and policies on resource efficiency, by signing agreements and commitments on natural resources consumption, e.g. fossil fuels consumption, and GHG emissions.

Building energy consumption in the European Union is about 40% of total primary energy consumption and thereby buildings are taken as one of the main sources of greenhouse gases (GHG) emission. Hotel buildings play an important role in energy consumption not only because of the sector's continuing growth but also because of its increasing energy demand.

On the one hand, the accommodation sector contributes to climate change. On the other hand, it is severely affected by the consequences of climate change, since climate is an essential resource for tourism. As agreed at the First International Conference on Climate Change and Tourism, held in Tunisia in 2003, convened by the World Tourism Organisation (WTO), this economic sector should be encouraged to minimize as much as possible their contribution to climate change. In 2007, at the Second International Conference on Climate Change and Tourism, in Switzerland, the participants agreed to apply new or already existing technology to improve the energy efficiency.

BIBLIOGRAPHIC RESEARCH

Through its relationship between construction, climate and building use type, Bioclimatic Architecture provides the users a comfortable environment in the interior spaces. Therefore, it minimizes the building energy needs for heating, cooling, ventilation and lightning. Bioclimatic Architecture enables a significant reduction in building energy consumption, hence its importance to energy efficiency in buildings.

Users can have a different perception of comfort. Therefore, comfort levels cannot be measured with an objective measuring method for all users alike. Law regulates minimum requirements and guideline values, in order to avoid unsatisfactory energetic performance of buildings. The coefficient of thermal transmission is the value related to the constructive elements of the building envelope, which varies accordingly to its component's thermal properties (thermal conductivity and thermal resistivity). The lower the coefficient of thermal transmission, the better is the envelope's energetic performance (in a Mediterranean climate).

The façade serves as the interface between the interior and the exterior space and it is one of the most significant contributors to the energy budget as well as the comfort parameters of a building, hence the need to rethink and revaluate its thermal properties.

Exterior walls vary accordingly to its structural function, constructive system, thermal and light transmission and exterior appearance. They can affect the users comfort due to distinct parameters: coefficient of thermal transmission, thermal inertia, thermal bridges existence and humidity issues.

Thermal insulation of an exterior wall decreases its coefficient of thermal transmission, which leads to a reduction of the energetic needs. It is more effective when located on the exterior surface of the exterior wall, since it conserves the interior thermal inertia, eliminates thermal bridges, avoids humidity issues, and increases the wall's durability, as it protects it from the exterior aggressions.

Windows also affect the users comfort due to its coefficient of thermal transmission. This value depends on the glazing and window frame properties. The solution, which is seen in general as the most energetic efficient solution is the one with double-glazing and PVC frame. Double-glazing provides a more effective barrier between the internal and external environments and PVC properties are inferior to those of other materials used in façade construction. In addition, PVC is impact and scratch resistant and it is recyclable.

However, there are other parameters related to windows that can also affect the interior environment such as solar radiation (solar gains) and gap ventilation (air penetration through window joints). The last one is solved by sealing the joints and the first one by using shading devices.

In the present case study, as well as in most of the situations, thermal insulation and window replacement is the solution to this problem, reducing about 50% of the heat loss through the façade.

Passive strategies for both heating and cooling differ with the local climatic conditions. Conditions in cold climates require heating strategies and those in tropical climates favor year round cooling. Passive design for temperate climates, however, requires more technically sophisticated solutions, due to unstable climate conditions. That means that heating strategies in winter should not result in overheating problems in summer. Conversely, cooling strategies should not lead to discomfort in winter.

Heating strategies for a temperate climate consist essentially in using solar energy (radiation), in which glazing system plays a decisive role. Its capacity of absorbing solar radiation depends on sizing, orientation and thermal properties of the glazing itself.

In a temperate climate, the most important passive cooling strategies are the natural ventilation and sun protection. Natural ventilation not only provides comfort, by avoiding overheating of the interior spaces but it favors the indoor air quality by refreshing the air inside. However, as mentioned, gap ventilation may origin discomfort in winter. Sun protection is possible through shading devices, which can as well regulate glare and privacy.

CASE STUDY

The building studied in this dissertation is a three star hotel in the heart of Lisbon and it has been constructed before the existence of a building code referent to the thermal characteristics of buildings. Its exterior walls are composed of brick masonry, single glazed aluminum windows and it registers thereby an unsatisfactory thermal behavior. From the outside, the façade shows some pathologies, like fissurations and humidity spots, and it also looks outdated.

Having never went through an intervention such as a façade refurbishment in twenty years and knowing the relevance of reducing the energy consumption, the hotel administration has decided it is the time to do it. However, there are some particular aspects to have in considerations.

Occupancy rate: the refurbishment should happen in the time of the year, when the tax is lower and should happen rapidly, so the guests are not disturbed and the hotel does not lose revenue;

Maintenance: the chosen solution should require low maintenance, as it represents a fixed cost for the hotel.

The first step on searching for a solution, in case of a refurbishment, consists in the analyses of the existent solution. The *Amazónia Lisboa Hotel* has been analyzed accordingly to:

- Type of Establishment
- Location and Climate
- Form and Solar Orientation
- Exterior Wall
- Glazing System
- Conservation Condition
- Exterior Appearance

There are three different exterior walls in this hotel: P1, P2 and P3, which require different solutions. Given the elevated number of possible construction systems and solutions, it is made a pre-selection of those solutions that comply with to the minimum requirements, having in consideration the main objectives, restrictions, climate conditions, the building use type and in addition the affordability of the investment.

The energetic contribution of each solution applied to the case study is calculated. The difference of the energetic needs between the existing solution and the possible solution, leads to a reduction of the energetic cost. The analysis compares different insulation materials and different thickness of the same materials. The results will serve to evaluate the relation between investment in thermal insulation and the consequent benefits. Thus, it is possible to understand the economic implications of the adoption of the thermal insulation.

After evaluating the energy performance and the economic viability, the selected solutions have been discussed from the energetic, economic point of view, as well as from its formal quality outcome.

The conclusion resulting from the discussion was that the choice of the appropriate solution cannot solely rely on the analysis of *energy performance / return on investment*. It also relies on intangible aspects such as the formal configuration of the building and the potential benefit resulting therefore, as well as the fact that the final decision still depends on the owner's will power.

GENERAL CONCLUSIONS

Our energy consumption pattern must change.

Main consumers of energy are responsible for the main energy consumption, thus should be responsive to the increasing need of consumption reduction.

As buildings play an important role in energy efficiency, architecture should have in consideration the building relationship to the local climate conditions and to the building use type as well as its envelope properties.

Present buildings that do not fulfill the thermal code requirements, should consider its envelope refurbishment, in order to improve its energetic performance and minimize its energy consumption, which favors the environment situation as well as the business (since it minimizes the energy costs).

In relation to the building code, it is only functional, when updated to the current technologic, economic and environmental context.

"A fundamental transformation must take place, one that does not just reduce energy consumption by a few percent, but one that involves a total rethinking of buildings."

KIBERT, C. *et al*, *High Performance Green Buildings*, Florida. 2002.