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Rehabilitation of buildings as an alternative to sustainability in Brazilian constructions

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Abstract: Rehabilitation and Sustainability complement each other insofar as new uses are defined for the existing constructions, avoiding the disposal and consequent environmental impact of this action. In Brazil, the culture of new construction still prevails, even with the relevant inventory of existing buildings, as indicated in studies conducted in Rio de Janeiro and São Paulo. Dissemination of knowledge of rehabilitation techniques can encourage the development of strategies for the implementation of these practices in Brazilian market. Therefore, this paper will try to indicate techniques that may be improved and incorporated into the rehabilitation of Brazilian constructions, aiming aspects of sustainability and reinsertion of contemporary construction in urban heritage.

1 Introduction

Civil construction is one of the most important sectors of Brazilian economy and its growth brings along a chain of companies linked to the production of inputs, services and equipment for this sector. Consequently, this macro-sector is accountable for producing large environmental impacts, since they depend, in a summarized way, on the extraction of raw materials, the production and transportation of materials and components, conception and design, execution (construction), use and maintenance practices and, at the end of its life cycle, the demolition or dismantling, besides the destination given to the waste generated during the building service life [1].

In a similar way, the search for sustainability presents itself as a necessity in a global scope, since it acts directly in the social, economic and environmental spheres of soci-

ety. However, in order to be achieved in the civil construction aiming at mitigating such impacts, it needs specific studies, since these impacts can occur in every phase of the life cycle of a building, whether they are: design, construction activity, use and operation, and, finally, actions of maintenance of the constructed facility [2].

The rehabilitation of buildings is one of the areas with a growing market in the country, especially in large urban centers where there is a low inventory of land available for new constructions. In 2000, the age distribution of the properties in the city of Rio de Janeiro was determined. In this survey, it was evidenced that only 39% of the buildings analyzed were less than 20 years old, which results in 61% of properties already old enough to be intervened [3].

Still in this context, considering that the service life of the buildings is around 80 years [4], it can be concluded that there is a large number of buildings capable of suffering some kind of intervention, and it is relevant to consider that the inventory of real estate that demand rehabilitation has the natural tendency to increase over time in cases of lack of permanent care. Thus, the young cities in Brazil face today what European major cities have experienced before: a reality of degradation established by the natural process of aging.

Another survey carried out in 2016 brings up a point that strengthens this demand, indicating that in the city of São Paulo, there are over two million square meters of unused or underused buildings and undeveloped land [5]. Taking into account that rehabilitated properties promote improvements in their surroundings, it is justified that studies conducted in this scenario may be relevant when promoting rehabilitation actions aiming at the territorial improvement in the long term.

However, stock of buildings alone is not the only justification to intervene. Thus, the decision to perform an intervention aimed at rehabilitation is conditioned by a pre-diagnosis, i.e., an assessment “in situ” is required, which will establish the status of existing structures, in addition to an investigation of documents and designs which will indicate the characteristics of the construction [6]. In this way, diagnostic tools should be used to support the viability of actions, which may be indicated, for example:

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MER HABITAT – Méthodes d’Evaluation Rapides, TEST HABITARE e EPIQR [7].

Therefore, the executed diagnosis will guide the planning of the building to be recovered. At this stage, parameters for sustainability should be incorporated, leading to incremental gains in projects, where actions are carried out in order to find synergy with the environmental values that exist in the current society, and also contribute to minimize the impact they generate in the built environment [8].

Also, the sustainability parameters for civil construction aim not only to protect the rights of the ecosystem as a whole, but objectively seek the construction of a healthy building, which provides protection and comfort for its users [9].

In this way, the present article aims at exploring the current view in Brazil for the valorization of remodeling practices of buildings as an alternative to reduce the impacts caused by the sector, contributing to the consolidation of sustainable practices in the preservation of the facility, promoting the improvement of the environmental conditions and the quality of life of the region intervened.

2 Rehabilitation of buildings

The term rehabilitation has two connotations: it can be seen as an action in the building itself, or in a more comprehensive way, an action involving the urban restructuring of the region where the building is located [10]. Thus, the rehabilitation of buildings can be understood as the set of operations which aim to increase the level of quality of building systems, so as to achieve compliance with functional requirement standards which are stricter than those planned [11].

Schematically (Figure 1), it can be said that urban rehabilitation is inserted in the context of civil construction and that the rehabilitation of buildings, in turn, refers to a wide range of actions which seek to recover the usability of a certain facility [12].

Restoration, renovation, maintenance and retrofitting are the main concepts of the Rehabilitation of Buildings, and they can be defined as:

- **Restoration:** the set of actions whose objective is to preserve and reveal the aesthetic and historical values of the monument, based on the respect for the original material and authentic documents [13];
- **Renovation:** the alteration of the conditions of an existing building, aiming at recovering, improving or increasing its habitability, usability or safety conditions,

Figure 1: Rehabilitation of buildings in the civil construction sector and its activities [12].

with or without a change of function, other than maintenance [14];

- **Maintenance:** the activities to be carried out to conserve or recover the functional capacity of the building and its constituent systems, so that they satisfy the needs and safety of its users [15];
- **Retrofitting:** it consists of the union of the term "retro", from Latin, which means to move backwards and of the English term "fit", which means to adjust, resulting in the concept of "reconversion". That is, it is about the renovation of a building, an intervention on an estate so that the old one is reformulated into a new one [16].

The processes for rehabilitation, besides being an ally with sustainability, must also meet the functional requirements. Thus, they are strategies to adapt the building to new uses, the preservation of the city's historical heritage and the improvement of the performance of buildings in the requirements of comfort, energy efficiency and water consumption. In addition, one must analyze the motivation of the intervention in favor of other construction solutions and the following factors, which justify the practice of rehabilitation of buildings, are also highlighted [17]:

- Use of existing infrastructure in the environment and its location;
- Impact on urban landscape;
- Housing deficit and environmental sustainability
- More economy and efficiency than demolition solutions followed by rebuilding.

In a situation of economic instability, the interest in the preservation of the facility is recurrent, since the cost of improvements and their respective impacts on the envi-

ronment are lesser than the cost of disposal of the construction waste. Another point to be highlighted is the legal issues demanded by heritage institutes which aim to preserve the historical and cultural aspects that old buildings bring with them in their features.

3 Sustainability in Rehabilitation

Sustainable or "green" construction can be understood as the set of techniques and practices of design, construction and maintenance which minimize the total environmental impact of a building [18]. The materials used to build, renovate and maintain the building are also impacting, as the amount of water and energy used throughout its service life (Figure 2).

Figure 2: The construction of a building produces several environmental effects [18].

The renovation of the facility constructed can be considered a more intensive and laborious activity than a new construction, since it requires more knowledge and experience on constructive techniques from the time of the construction of the facility. On the other hand, it brings with it professional, cultural and knowledge advancement benefits in terms of learning sustainable construction techniques which are adapted to the old scenario. Thus, rehabilitation practices when incorporated by a sustainable modeling should take into account, among other considerations [18]:

- Improvement of thermal insulation
- Improvement of air permeability;
- Improvement of the performance of the window frames or use of a double system which promotes better insulation for heat and sound;
- Improvement of coatings aiming to increase the service life;

- Application of sustainable components and systems;
- Landscaping intervention;
- Improvement of energy active controls.

Rehabilitation is part of the scope of sustainable solutions because of its own vocation to reuse the existing building, which is expanded and improved rather than demolished and abandoned. The useful space recovered can be converted into a more efficient and healthy space, promoting savings in energy costs, avoiding the creation of tons of discarded waste and also avoiding the intensive consumption of new material that would be required for a new structure, for example [18]. In addition, rehabilitation becomes an opportunity to benefit the space with more efficient equipment, from the water, energy and duration perspectives, whose knowledge about adequate maintenance can be widespread.

4 Good Practices in Sustainable Rehabilitation of Buildings

The Sustainable Rehabilitation of Buildings has multiple aspects because it transits in the knowledge of the constructive techniques and in the supply of the materials used in the construction. Furthermore, it considers the knowledge of the local constructive culture versus the insertion of the facility in the historical heritage and the choice of how it should be rehabilitated. In this context, actions should be considered for systems of a building as rehabilitated. It's important to enhance that these actions are already consolidated for new constructions, and should be improved so that they can be adopted with efficiency, observing aspects of how to consider sustainable actions presented in the previous item. Among them, can be mentioned [18]:

- In the scope of insulation and sealing, the materials and the installation method must be considered respecting the parameters of the climate where the structure is found, luminescence, skill and know-how of the team and the budget destined for its execution. One of the important points is the roof, where the greatest loss of energy occurs in a building.
- For foundation structures, durability is a critical item. Water and excessive soil moisture are factors that generate recurring structural and maintenance problems. Protecting the building through an internal and external waterproofing system may keep the foundation dry, extending its service life.

- The walls and floors in rehabilitation depend on factors such as the weather and the availability of the material on site. There is a wide range of materials ranging from wood to high efficiency systems such as the Structural Insulated Panel (SIP). Each system has unique characteristic, durability, energy efficiency and cost. Thus, it is the responsibility of the people involved to identify the characteristics necessary to better serve the building. One must remember that it is always possible to combine local alternative solutions, such as the use of mud and hay bale with traditional solutions such as masonry brick.
- In the renovations, the more complex the roof design, the more difficult the drainage of rainwater will be. Despite the use of sealing materials of acknowledged quality, a fast and continuous flow must be projected, avoiding the accumulation of moisture.
- The frames are part of the envelope of a construction. Thus, in the renovations, the replacement of the external frames should guarantee sealing parameters, thermal insulation, spatial orientation of the structure and adopted materials. The selection of frames is essential for a high-performance building in its service life.
- In rehabilitations that affect the external finishing, some questions must be raised. Initially, must be verified if the building is protected by heritage institutes and where can be found materials equivalent to the existing ones. In some cases, the paint may contain harmful elements such as asbestos or lead, and their removal and disposal must have adequate planning. The choice of finishing should be beyond the aesthetic concepts, considering also the effect of the waterproofing protection, its recyclability, the risks of the composition of the material and, in indoor environments, the effects on the health of the occupants.
- The choice of an interior finishing should follow the criteria of durability, recyclability, environmental impact, use of renewable resources and climate suitability.
- The patios, balconies and decks are spaces of external interaction in a building, where there is a better circulation of air. In rehabilitation, the spaces unprotected against external agents must be made of materials suitable for this purpose. One should be aware of the influence of the external area on the internal elements of the rehabilitated building, as these spaces can become openings in the building for the entrance of water, dust, biological agents, among others.
- The choice for an adequate lighting is a relevant factor in the electrical system of a rehabilitated building. Harnessing the external lighting when possible and

installing efficient equipment generate a lower cost in energy consumption.

- Old buildings often waste water through inefficient fittings, leaks and long pipes. In addition to repairing, replacing the sanitary ware with modern accessories, implement water reuse techniques and flow control valves increase the efficiency of water consumption.
- The HVAC system that reduces air infiltration and maintains pressure uniformity requires appropriate designs for better energy utilization and installation method in rehabilitated buildings. The compatibility of new components with the existing ones is one of the challenges of this system, that is, it requires specific design and adaptation in order not to affect other construction systems.

It should be noted that Sustainability and Retrofit are often outdated in legal standards and technical criteria, as they are not committed to the qualification of the workforce, and also due to the inexistence of courses disclosing the constructive solutions found for sustainability in rehabilitation [19].

Another important aspect is the concern with the service life of the proposed intervention, together with the future need for the incorporation of new technologies. In this context, it is common not to convince users of the use of innovative materials, giving rise to mistrust in the applicability of new constructive processes due to the lack of knowledge of their pathologies and the life cycle that will follow [20].

5 Final Considerations

The alignment proposed by the adoption of rehabilitation in an economy that rewards heritage actions makes buildings efficient as long as the prospective scenarios are created to present results that are appealing to the societies. Therefore, indicating the real long-term advantages in adopting this set of actions, the opportunities to stabilize or even reduce emissions from the construction sector and the adoption of sustainable measures are challenges for a retrofitting strategy of the existing built inventory.

It is important to emphasize that, in Brazil, diagnostic techniques that guide the decision to rehabilitate are not yet consolidated in comparison with the European reality. This is a point of relevance so the concepts presented can be applied, and the dissemination of European's good practices should be encouraged, in order to contribute to

Brazilian market reach international standards for performance and development in this area.

In addition, commercial advantages of these interventions already indicate that there are technical knowledge available internalized in companies. This makes it possible for each building produced or reformed to reach more efficient indicators than the current ones, since they allow permanent adequate use of water, new consumption reductions associated with the adoption of sustainable equipment and the promotion of conscious consumption by the society.

However, it is important to emphasize that there are disadvantages that must be studied in order to make sense with the real feasibility of facility's interventions. Therefore, one should analyze the risks of the solutions encountered, how long they will last, how much material they will save, how much energy will be consumed, whether the solutions are cost-effective, how much facilities will be incorporated, whether there will be proper use and operation management of the building.

Considering the concepts discussed, one may verify that when observing cities that already award solutions in rehabilitation of buildings with sustainable tools and techniques, it is possible to find purposes that are already consolidated guidelines for Brazilian solutions, allowing the adaptation to the needs of the country and progress in efficient ways.

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