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PATHOLOGICAL MANIFESTATIONS IN HISTORIC BUILDINGS: A CASE STUDY AT THE PATU HISTORICAL SITE, CEARÁ

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ABSTRACT

Historical heritage plays an important role in the preservation of memory, hence the importance of preserving this legacy. Many monuments are abandoned and in a state of deterioration, favoring the emergence of pathological manifestations that have the potential to significantly reduce the useful life of buildings if they do not receive adequate treatment. This article presents a study on the pathological manifestations in buildings located in the historic site of Patu, in Senador Pompeu, Ceará, the only one of the concentration camps with remaining physical remains. The text presents a descriptive and exploratory research with a qualitative approach carried out from the survey of the main pathological manifestations, identifying cracks, mapped fissures, vegetation, mold, and detachment. From the study, it was possible to map pathological manifestations on the facades through identification sheets and to analyze their possible causes preliminarily. The text presents data on the mapped pathological manifestations and seeks to contribute to the discussion on the preservation of physical elements, but also of history and culture for present and future generations.

Keywords: Historical heritage. Pathological manifestations. Pathologies.

Revista ARACÊ
ISSN: 2358-2472

INTRODUCTION

During the late nineteenth and early twentieth centuries, northeastern Brazil – one of the most populous dry areas in the world – suffered from long-lasting drought periods, referred to by the newspapers of the time as the "great droughts", notably those that occurred in the years 1877, 1915, and 1932. In response to this problem, among other actions, the government acted in the implementation of the so-called barracks and, later, the concentration camps, places of confinement of the migrant backcountry population and which were used as isolation strategies for the scourged who migrated to Fortaleza (Rios, 2001; 2020). In Ceará, eight concentration camps were erected at two different times (1915 and 1932), six of them in cities in the interior and two in the capital. Together, they came to shelter more than tens of thousands of drought migrants from various parts of Ceará and even from other states, functioning as imprisonment spaces strategically scattered along the migration routes, preventing this population from reaching Fortaleza in search of help (Rios, 2001; 2020). Among these concentration camps, only Campo do Patu, located in Senador Pompeu, still has buildings remaining from that time. The preservation of this chapter in the history of the people of Ceará has been sought, at least since the 1990s, by various subjects and institutions. In 2019, the historic site was listed at the municipal level and, subsequently, the listing at the state level was demanded, carried out in 2022.

Even with the intention of preservation, most of these structures are in an advanced state of deterioration. These historic sites face a panorama of abandonment, being impacted by pathological manifestations that compromise their structural integrity and constructive elements. In addition, they suffer from acts of vandalism. The durability of these structures is attributed to the quality of the materials and construction techniques used at the time. However, several of them need restoration efforts, while others, in a state of ruin, must be preserved as intrinsic elements of history. In this context, it is questioned how pathological manifestations in buildings considered as neglected architectural and historical heritage impact not only physical preservation but also the cultural appreciation and historical identity of a community. This text presents the analysis of pathological manifestations in historic buildings based on the case study at the Patu Historical Site in Senador Pompeu, Ceará. The manuscript is structured in four parts, in addition to this introduction. In the second part, some theoretical and conceptual foundations about pathological manifestations and the preservation of historical heritage are discussed. The third part presents the Patu Historical Site, the object of study that supports this text. The

Revista ARACÊ
ISSN: 2358-2472

fourth part deals with the results and discussions about the research carried out. At the end, some final considerations are presented.

PATHOLOGICAL MANIFESTATIONS AND PRESERVATION OF HISTORICAL HERITAGE

IMPORTANCE OF HISTORICAL HERITAGE AND PROFESSIONAL PERFORMANCE IN CIVIL CONSTRUCTION

Cultural heritage, according to Lopis (2017), is a symbol of historical experiences that are eternalized through objects and monuments, building a valuable set of meanings that indicate origin, identity, and future direction. This understanding emphasizes that heritage goes far beyond its physical existence, incorporating subjective elements of deep value. In this context, memory plays a key role, allowing memories and heritage itself to remember the past vividly (Lopis, 2017). The patrimonial value of an asset, according to Tomaz (2010), resides in the attribution of meanings and senses that it has for a specific social group, and this attribution justifies the need to preserve this asset. This preservation, in turn, contributes to the maintenance of society's identity and cultural memory (Medeiros and Surya, 2009). Raising awareness of the importance of preserving historical and cultural heritage will ensure that future generations have access to this cultural heritage and understand the process of national identity formation.

The preservation of monuments and historical sites is a complex challenge in modern society, involving several areas, such as culture, humanities, social, technical, economic, and administrative aspects. For the engineers, this intervention is peculiar due to the need to ensure the integrity of the structure and maintain its safety. Preservation involves not only the iconic appearance but also the conservation of materials, construction techniques, and original structure, which are fundamental elements for the monument's identity. Thus, conservation encompasses both aesthetic and material and historical aspects, requiring an interdisciplinary approach (Billota et al., 2020). Often, safety and use requirements conflict with the preservation of the iconic, historical, and material integrity of monuments. Conservation is usually overseen by experts in Art History or Archaeology, who impose restrictions that may seem unreasonable to engineers seeking safe solutions. While engineers tend to apply procedures intended for new structures, conservators seek to protect the formal, material, and historical integrity of the monument. Finding a balance

Revista ARACÊ
ISSN: 2358-2472

is challenging due to the lack of a general theory that guides the actions of all involved (Billota et al., 2020).

Civil construction is made up of a diversity of professionals and plays a crucial role in modern society, dedicating itself to the planning, construction, and maintenance of infrastructure. Professionals in this area, when designing and executing projects, always seek to ensure safety and efficiency in every aspect. Throughout history, this has contributed to avoiding accidents, saving lives, and preventing material damage (Queiroz, 2019). In addition, these professionals play an important role not only in the design of new buildings and in solving problems but also in the preservation and maintenance of structures and assets that already exist, as pointed out by Bilotta et al. (2020). In the process of preservation, maintenance, and restoration of historic buildings, Diagnostic Engineering stands out. This field has the purpose of working in buildings, carrying out investigations to identify possible complications and offer solutions for pathological manifestations.

PATHOLOGICAL MANIFESTATIONS IN HISTORIC BUILDINGS

Understanding pathological manifestations in historic buildings is important for the effective conservation of historical heritage. These manifestations, which range from structural damage to infiltration and deterioration problems, pose challenges that require specialized knowledge. In this section, the various forms of pathological manifestations that can affect historic buildings are explored in detail, with an understanding of how civil engineering plays a vital role in identifying, diagnosing, and solving these problems. The study and identification of constructive pathological manifestations are based on investigations and analyses aimed at understanding and, when necessary, correcting the problems identified. Essentially, it is a domain of study that seeks to identify the nature of the problematic condition to ensure that it is treated effectively and permanently (Bolina, Tutikian, & Helene, 2019). Often, problems are not immediately recognized and require detailed inspection processes and analysis supported by various types of assays to reach accurate conclusions and guide appropriate correction.

Historic buildings, a particular set of buildings, stand out due to their great cultural value, the diversity they present, the complexity of their structural systems, and the lack of detailed information in the technical-scientific field about the properties of the materials used, the construction methods, and the structural behavior. This makes them a

Revista ARACÊ
ISSN: 2358-2472

challenging topic of great interest for professionals in the area (Mesquita, 2019). The prolonged period of exposure to environmental effects can cause changes in the performance of structural systems over time. In certain cases, the lack of adequate maintenance or modernization measures can contribute to these constructions becoming more fragile, thus increasing the risk of failure in situations of extreme environmental events, such as earthquakes, hurricanes, floods, and others. On the other hand, the implementation of reinforcement measures that do not consider the specific characteristics of historic buildings, such as their maximum load-bearing capacity, can result in serious structural safety problems, even if the intention is the best possible (Mesquita, 2019). Figueiredo, Varum, and Costa (2011) point out that old buildings, due to their long existence, exhibit signs of deterioration that affect the stability of the structural system. Deterioration is often a result of natural wear and tear over time or specific actions. Key factors that play a significant role in the deterioration of structures include:

- Environmental Factors (changes in temperature, humidity levels, excessive exposure to heat, ultraviolet rays, dry air, wind, rain, and presence of saltpeter);
- Chemical Factors (dust particles, soot, pollutant gas emissions, and presence of saltpeter);
- Factors of Biological Origin (vegetation, insects, fungi, bacteria, rodents, and atmospheric pollution);
- Factors of Human Nature (manipulation, acts of vandalism, improper use, vibrations, improper transportation);
- Factors of Natural Origin (floods, fires, natural disasters, vibrations, earthquakes, winds, rains).

DIAGNOSIS OF PATHOLOGICAL MANIFESTATIONS AND DAMAGE MAPS

When a structure has pathological problems, it is essential to carry out a detailed and planned inspection to assess its conditions, identify anomalies and their causes, and determine the necessary measures for recovery or reinforcement. The actions to be taken must consider the importance of the structure in terms of strength, durability, and the surrounding environment, especially environmental aggressiveness. The inspection process involves three steps: data collection, analysis, and diagnosis. Data collection covers the classification of the environment, visual observations, measurements, damage estimation, identification of pathological symptoms, analysis of projects, instrumentation,

Revista ARACÊ
ISSN: 2358-2472

and special tests. The analysis of the data aims to understand the behavior of the structure and the origin of the problems and ensure that serious anomalies are not hidden by superficial problems, in addition to considering multiple factors that cause the pathological symptoms (Souza; Ripper, 1988). The diagnosis occurs after the survey and analysis stages and depends on several factors, such as economic, technical, safety, and comfort, and can lead to different conclusions. In extreme cases, demolition of the structure may be recommended due to the high costs and extent of the damage, when recovery or reinforcement is not feasible in terms of cost-benefit (Souza; Ripper, 1988).

Several approaches are available for the identification of pathological manifestations. Several methods, both destructive and non-destructive, have emerged to diagnose problems in buildings. In essence, these methods can be employed to acquire data related to the structure, such as its configuration, dimensions, depth, and physical condition, as well as to provide parameters associated with deterioration processes or the risk of damage to the structure (França et al., 2011). A damage map is a detailed visual representation of the signs of degradation in a building, including photographs and detailed information. It works as a document that condenses the results of the analysis of structural and functional deterioration in the materials, procedures, systems, and construction components of a building. In the context of a historic building, the creation of the damage map requires the construction of a database, which is composed of the so-called Damage Identification Sheets (FID). These forms are standardized documents that record pathological manifestations with graphic and photographic information, playing a fundamental role in the elaboration of the damage map (Tinoco, 2009).

PATU HISTORICAL SITE

HISTORY AND CHARACTERISTICS OF THE PATU HISTORIC SITE

During the late nineteenth and early twentieth centuries, northeastern Brazil – one of the most populous dry areas in the world – suffered from long-lasting drought periods, referred to by the newspapers of the time as the "great droughts", notably those that occurred in the years 1877, 1915, and 1932. In response to this problem, among other actions, the government acted in the implementation of the so-called barracks and, later, the concentration camps, places of confinement of the migrant backcountry population and which were used as isolation strategies for the scourged who migrated to Fortaleza (Rios, 2001; 2020). In Ceará, eight concentration camps were erected at two different times (1915

Revista ARACÊ
ISSN: 2358-2472

and 1932), six in cities in the interior and two in the capital. Together, they sheltered tens of thousands of drought migrants from various parts of Ceará and even from other states, functioning as imprisonment spaces strategically scattered along the migration routes, preventing this population from reaching Fortaleza in search of help (Rios, 2001; 2020).

In mid-1933, when the first rains of the season marked the end of the drought, the activities of the concentration camps were officially closed. Local newspapers defended the distribution of tickets for refugees to return to their homes in the countryside or to move to other states if they were not allocated to some public work. At the same time, there was also the need to keep workers in Fortaleza, guaranteeing cheap labor for the urban improvement works. Some of the backcountry migrants returned to the hinterland, but others remained in the capital in disobedience to government rules and orders (Rios, 2014, p. 78). With these spaces having lost their function and being in disuse, the concentration camps were abandoned, generating the disappearance of their physical structures. Currently, of the seven concentration camps built in 1932, only Campo do Patu, in Senador Pompeu, has physical remains remaining (Neves, 1995).

In 1919, seeking to mitigate the effects caused by droughts in the backlands of Ceará, the newly created Federal Inspectorate of Works Against Droughts (IFOCS) – currently the National Department of Works Against Droughts (DNOCS) – began the construction of the Patu Dam in Senador Pompeu. The work was paralyzed in 1923, and a set of buildings erected by professionals linked to the British company responsible for the work and that would serve as support for the construction of the Patu dam, notably with the purpose of housing the workers, remained on the site. The complex of buildings erected became known as Vila dos Ingleses, with several buildings such as residences for engineers, a hospital, railway station, warehouse, workshop, power generation house, houses for the workers' village, warehouse, and gunpowder houses.

With the great drought of 1932, of such proportion that it was treated by the then president Getúlio Vargas as a national issue, there was the decision of the state government to build concentration camps in the countryside and the capital. One of them was installed next to the works of the Patu dam. This was for two main reasons. First, because of the geographical location of Senador Pompeu, located in the micro-region of the Central Sertão, which also had an important railway axis that connected the capital to the south of the state. Second, because of the availability of a set of previously unoccupied buildings that could be used to house the scourged who arrived at the city station (Coelho,

Revista ARACÊ
ISSN: 2358-2472

2021). In 1933, with the beginning of the first rains, the concentration camp was dismantled. More than sixteen thousand migrants passed through the place, many dying from contagious diseases, a condition aggravated by the confinement and the precarious facilities. In addition to several buildings in different states of conservation, most of them in a state of deterioration, there is currently a cemetery built in memory of those who lost their lives during this period of confinement. The remaining buildings and ruins represent a testimony to the policy of confinement and isolation implemented by the government, which was characterized by the exclusion and exploitation of people in poverty (Coelho, 2021).

CONSERVATION CHALLENGES IN THE HISTORIC SITE OF PATU

Popularly called "dam mansions", the buildings that originally belonged to the commission in charge of managing the Patu concentration camp remain as testimonies that have withstood the passage of time, despite the neglect of public authorities to keep alive the memory of the tragedy of the 1932 drought (Lima, 2021). The area used in the concentration camp in Senador Pompeu is located on the outskirts of the city and has maintained, over the years, its rural characteristics without urban interventions. These rural characteristics constitute a potential for future intervention actions (Lima, 2021). In the context of the cultural heritage of Senador Pompeu, it was only in 2006 that the first legislation aimed at its protection was established. Before this, groups involved in the promotion and preservation of cultural elements, including the Patu architectural complex, faced difficulties with local authorities. Despite the existence of regulations aimed at protecting the region's cultural heritage, the effective implementation of conservation measures is hampered by challenges in their implementation (Lima, 2021). The preservation of this chapter of Ceará's history has been sought, at least since the 1990s, by various subjects and institutions. In 2019, the historic site was listed at the municipal level, and subsequently, the listing was demanded at the state level. In 2022, the Patu Historic Site was definitively listed by the Secretary of Culture of the State of Ceará.

Revista ARACÊ
ISSN: 2358-2472

Figure 1 – Ruins of the Workshop, in the historic site of Patu

Source: the authors.

Figure 2 – Ruins of the Station in the historic site of Patu

Source: the authors.

The remaining remains of the concentration camp in Senador Pompeu are abandoned and forgotten on the outskirts of the city. The area in which they are located is avoided by the population due to its state of neglect and the lack of interest of both government authorities and the community itself, which has not established a significant link with these ruins in terms of collective identity. Due to its historical importance, it is crucial to protect the material and symbolic signs of this period, promoting greater visibility

Revista ARACÊ
ISSN: 2358-2472

of both the materialities and the stories that persist and are transmitted, as well as those that have been erased over time (Coelho, 2021).

RESULTS AND DISCUSSIONS

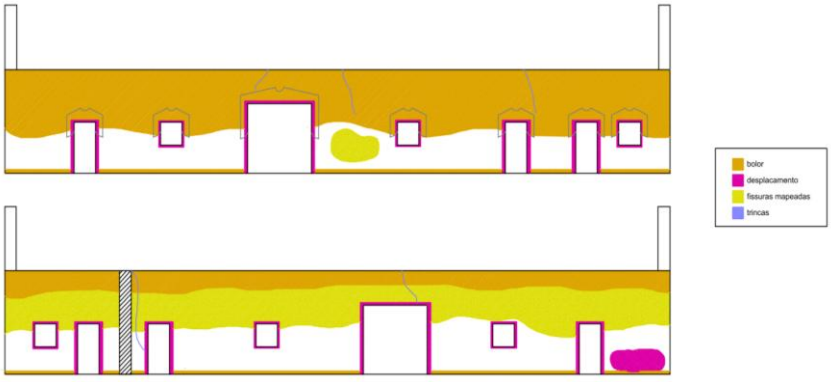
DESCRIPTION OF THE BUILDINGS ANALYZED: STATION AND WORKSHOP

The ruins of the old train station (figure 1) are located on the banks of the Patu road. This place played a crucial role in the conformation of the historic site, as it was where the equipment and machinery used in the construction of the dam were received. During the drought of 1932, the Station also served as a landing point for drought victims arriving in the area. The station functioned as a depot for tools and supplies sent to the region. Although the railroad branch was deactivated and removed in the 1990s, it is still possible to find traces of it. The workshop, also known as Casa da Luz, housed equipment for the generation of electricity for the construction of the Patu dam. During the drought, it played an important role as a support point for the guards and for carrying out activities aimed at displaced people. A distinctive feature of this building compared to others is the presence of the national seal stamped on its façade.

MAPPING OF PATHOLOGICAL MANIFESTATIONS

The station building (figure 2) was divided into 10 facades, comprising 4 external and 6 internal, mapped and identified in a floor plan with the location of each of the facades for reference. Views were created from each of the facades, identified with the initial "E" for "station" and numbers ranging from 1 to 10 (E1, E2, E3, etc.). With these graphic representations in hand, the manifestations found were mapped, which were practically the same on all facades: mold, mapped fissures, cracks, and detachment.

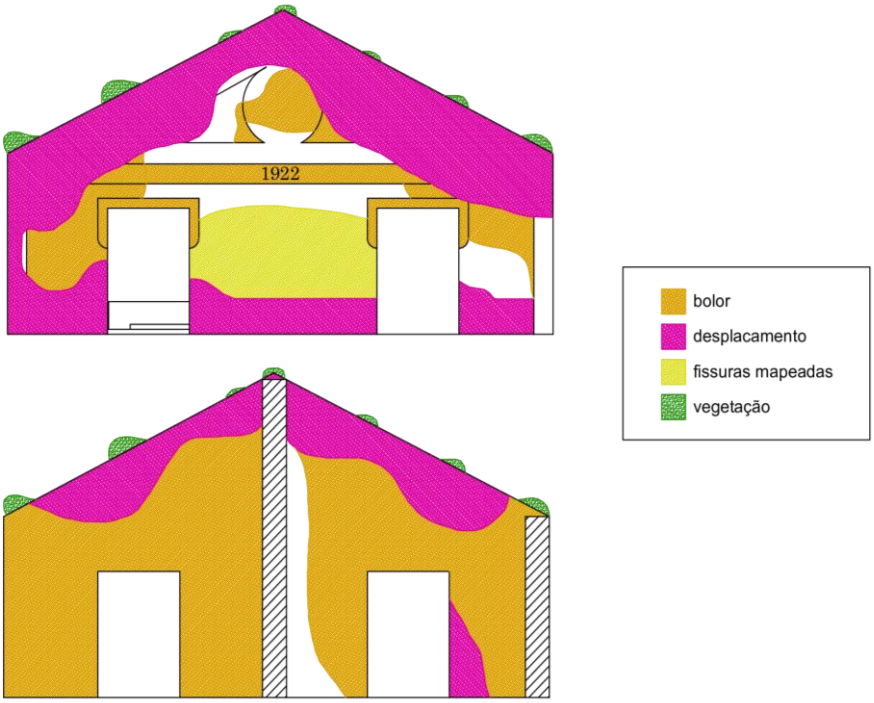
Figure 3 – Damage mapping on the E1 and E2 facades of the Station



Source: the authors.

Revista ARACÊ
ISSN: 2358-2472

Figure 4 – Damage mapping on Facades 01 and 02 of the Workshop



Source: the authors.

The workshop building was subdivided into 12 facades, 4 external and 8 internal, registered in a floor plan indicating the location of each of the facades for reference. Subsequently, graphic representations of each façade were created, identified with the initial "O" for "workshop" and numbers from 1 to 12, following the same mapping approach used in the station. With these views in hand, the manifestations found were mapped, which were largely similar to those of the previous building (except issues related to vegetation) and were repeated on practically all facades: mold, mapped fissures, cracks, detachment, and the presence of vegetation.

POSSIBLE CAUSES OF PATHOLOGICAL MANIFESTATIONS ON FACADES

Carrying out immediate repairs after noticing problems in construction is essential in order to prevent further damage. The delay can make repairs unfeasible. To ensure that corrections are effective, it is necessary to accurately identify the causes of the problems and resolve them before any restoration. Otherwise, irregularities can resurface in the repaired areas and spread to other parts. Identifying the causes and assessing the extent of the damage are essential steps before deciding which approach to take (Caporrino, 2018).

Revista ARACÊ
ISSN: 2358-2472

Mold

The presence of water on building facades can lead to the growth of fungi, causing stains, such as mold, and damaging coatings. According to Caporrino (2018), among the main factors that contribute to these stains, drainage problems and lack of maintenance stand out. In addition, it can be stated that the main causes of mold include constant humidity, the presence of soluble salts in masonry and water, non-carbonated lime, and shaded areas (Caporrino, 2018). In the case of facades in which mold stains were identified on the upper part, the possible cause of the appearance of this occurrence can be evidenced as inadequate water flow, which ended up resulting in a humid environment conducive to stains. This is due to the current absence of coverage in the building, which allows water to run down the walls when it rains. An indication of this is the direction of the stains, which follow the direction of rainwater runoff.

Removal

Detachment in mortar coating is a problem in buildings characterized by mortar boards that become rigid, brittle, and detach from the surface. This can occur due to various causes, such as the presence of mica on the contact surface, the use of very rich mortars, thick layers of mortar, overly smooth base surfaces, hydrophobic substances at the base, lack of a roughcast layer, and thin mortars (Caporrino, 2018). In most old buildings, it was common to use adobe bricks without the application of waterproofing, which made the material susceptible to damage caused by water due to its high permeability.

Revista ARACÊ
ISSN: 2358-2472

Figure 5 – Detachment of the mortar coating

Source: the authors.

In some cases, coatings were found, such as chapisco, plaster, and whitewash (painting with lime). One of the solutions adopted at the time was the construction of more extensive eaves to keep the water as far away as possible from the walls. Initially, the suspicion arose that the absence of Chapisco was the cause of the detachment. However, after visits to the site, it was found that in an area affected by the landslide, there was, in fact, a layer of roughcast (figure 5). In the image, the presence of a thick layer of mortar is evident. The application of an excessively thick layer of mortar can result in the detachment of slabs since the great thickness generates distinct variations in expansion and retraction between the base and the coating.

Cracks

One of the types of pathological manifestations found in the buildings analyzed were cracks around the opening of frames. In masonry walls with doors and windows, it is common for cracks to occur at the corners of the openings and below the window sills. Due to the decreased strength in these areas compared to a continuous wall, the distribution of

Revista ARACÊ
ISSN: 2358-2472

cracks in a wall built on a rigid support is determined by the standard of compressive forces (Thomaz, 2020). Another type of pathological manifestation observed was vertical cracks in masonry. According to Caporrino (2018), cracks in structural masonry due to the action of vertical loads tend to develop predominantly in the vertical direction and the upper region of the masonry immediately below the application of the load. On the façade damage map, it is possible to identify this specific type of crack. Caporrino (2018) points out that cracks in structural masonry result mainly from the application of loads beyond the projected bearing capacity.

Cracks mapped

These manifestations have different forms that spread across the surface. The main cause seems to be the shrinkage of the base mortar, caused by the excess of fine particles in the mixture, resulting in a rich composition that favors shrinkage. This culminates in cracks and micro-cracks with a pattern mapped onto the facades, where dirt accumulates, leading, in many cases, to the appearance of mold stains in the most impacted areas. On the O11 façade, the cracks with a mapped pattern are quite evident. Most facades are affected by this problem, and given that the plaster has not been renewed (which would eliminate the retraction of the base as a cause), it is reasonable to infer that the inadequate execution of the base (construction procedure) is the main origin of the cracks. The prolonged time of exposure to the sun, in a city subject to periods of high humidity and intense heat, combined with the lack of maintenance, further aggravates this situation.

Vegetation

The presence of cacti growing on the facades of buildings was identified, a common occurrence in certain regions. In the case of this study, where the buildings are located in areas close to natural vegetation, the presence of cacti is even easier. This happens due to the availability of essential elements for the growth of vegetation, such as soil brought by the wind, organic matter from the feces of animals that transit through the area (along with various microorganisms), seeds transported in the manure of animals that feed on the fruits of cacti, rainwater, sunlight and the presence of the atmosphere. The cactus is the predominant plant, as it can store water inside, which allows it to survive in an environment where rainfall is seasonal and most of the year is marked by drought. Therefore, it is

Revista ARACÊ
ISSN: 2358-2472

common to find cacti growing in semi-arid buildings due to their ability to withstand the adverse climatic conditions of the region.

SOME FINAL CONSIDERATIONS

The preservation of historical and architectural heritage is essential to keep the memory and identity of a society alive. Listed historic buildings carry not only an aesthetic charge but also an intrinsic narrative to the events and values of an era. However, the passage of time and the effects of exposure to the environment can cause damage to structures, compromising not only their physical integrity but also their ability to convey their historical message. It is in this context that the analysis of pathological manifestations in historic buildings becomes important. The study of these manifestations is essential to understanding the degradation processes and identifying the corrective measures necessary to preserve the building. In this sense, it becomes relevant to map and analyze the pathological manifestations of the Patu Historical Site, one of the concentration camps built in Ceará by the state government to house those plagued by drought.

The analysis of the predominant pathological manifestations on the facades of two of the buildings that make up the Patu Historic Site revealed relevant problems for the conservation and maintenance of those buildings, such as cracks, mapped fissures, mold, vegetation, and detachment. The data collected and analyzed from the mapping of the damage to each of the facades of the buildings studied showed that mold and detachment stand out as the most frequent occurrences, registering 100% and 90%, respectively. In carrying out this study, some limitations were faced, the main one being related to the impossibility of addressing all the buildings of the historic site due to the large extension of the site and the various buildings belonging to it. Finally, it is argued that the data and information presented by this text about the pathological manifestations in buildings of the Patu Historic Site indicate that the study and analysis of pathological manifestations in historic buildings listed as architectural heritage are fundamental to ensure the preservation of these monuments and the continuity of their ability to tell stories and inspire future generations. By understanding and addressing the structural problems of these buildings, we are not only protecting our cultural heritage but also investing in the future of our society.

Revista ARACÊ
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