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PATHOLOGIES CAUSED BY INFILTRATION IN A LONG-STAY INSTITUTION FOR THE ELDERLY: A CASE STUDY

PATOLOGIAS CAUSADAS POR INFILTRAÇÃO EM UMA INSTITUIÇÃO DE LONGA PERMANÊNCIA PARA IDOSOS: UM ESTUDO DE CASO

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ABSTRACT
This paper is part of an extension project aimed at renovating the Carlos Romeiro Asylum, a long-stay institution for the elderly located in Conselheiro Lafaiete, Minas Gerais, starting from an initial conception about the current state of the building. For this, it was developed a literature review on the main cause of pathologies that affect the building, infiltration and humidity damage, and others. A case study will be presented, showing the main physical deficiencies of this resting house, to propose interventions based on Material Science and Civil Engineering. Because it is a place where the construction work must be done concomitantly with the circulation of people, this project needs to be divided into stages. It is important to point out that this work may involve both recovery materials and methods, which aim to reestablish the original conditions of the damaged structures, and reinforcement, which aim to adjust the resistant capacity of the structures according to their use. The development and application of this project will bring improvements to the elderly population of the asylum, enabling better health and mobility conditions inside the space where more than sixty old people live.

KEYWORDS: Pathologies. Infiltration. Civil Construction. Structural intervention. Structural reinforcement.

RESUMO
Este trabalho faz parte de um projeto de extensão que visa a renovação do Asilo Carlos Romeiro, Instituição de Longa Permanência de Idosos localizada em Conselheiro Lafaiete, Minas Gerais, a partir de uma concepção inicial sobre o estado atual da edificação. Para tal, foi desenvolvida uma

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revisão bibliográfica sobre a principal causa de patologias que afetam a edificação, infiltrações e danos causados pela umidade, entre outras. Será apresentado um estudo de caso, mostrando as principais deficiências físicas desta casa de repouso, para propor intervenções baseadas em Ciência dos Materiais e Engenharia Civil. Por ser um local onde as obras devem ser feitas concomitantemente com a circulação de pessoas, este projeto precisa ser dividido em fases. É importante salientar que este trabalho pode envolver tanto materiais e técnicas de recuperação, que visam restabelecer as condições originais das estruturas danificadas, quanto de reforço, que visam ajustar a capacidade resistente das estruturas de acordo com a sua utilização. O desenvolvimento e aplicação deste projeto trará melhorias para a população idosa do asilo, permitindo melhores condições de saúde e mobilidade dentro do espaço onde vivem mais de sessenta pessoas idosas.

PALAVRAS-CHAVE: Patologias. Infiltração. Construção civil. Intervenção estrutural. Recuperação estrutural.

1. INTRODUCTION

The term pathology in civil construction is dedicated to the study of errors and damage to the structural part of a work. The explanation for the appearance of pathologies is varied: lack of planning, poor working conditions, incorrect storage of materials used in construction, and inefficient labor are also some examples.

These pathologies can manifest themselves in various ways, such as cracks, fissures, infiltrations, damage from excessive humidity in the structure, among others. For being found in several aspects, they are called pathological manifestations.

Within this context, the Brazilian standard NBR 15575 (ABNT, 2013), in part, demonstrates the effort of the technical and scientific communities to improve the results of civil construction. It deals, among other things, with user requirements for habitability, namely: water tightness, thermal performance, acoustic performance, lighting performance, health, hygiene and air quality, functionality, accessibility, and tactile comfort. All these requirements are, directly or indirectly, connected to the possibilities of pathologies.

This paper will briefly present the most common pathologies in buildings, using a case study of the Carlos Romeiro Asylum in Conselheiro Lafaiete, Minas Gerais, as a reference for the application of theoretical concepts to practice. It is important to emphasize that the administration of the asylum authorized this study to be carried out. Besides, for the reader's better understanding, it should be noted that the word "asylum" refers to a long-stay institution, and is therefore adopted as a standard in this work.

Moreover, this work is based on local inspections carried out during technical visits, in which the main physical deficiencies of this nursing home were identified to propose interventions based on Material Science and Civil Engineering, necessary for the treatment and recovery of the entire building.

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2. PATHOLOGICAL MANIFESTATIONS

Some of the most common pathologies found in construction will be presented in the following topics, but they are not limited only to these. In the subsequent section, in which the case study is presented, other important considerations about these and other pathologies will be made.

2.1. The state of the art

The interest in a better understanding of pathological manifestations in buildings has increased in recent years, accompanied by several works found in the literature.

In the work developed by Ferreira and Lobão (2018), due to numerous flaws present in buildings, pathological manifestations are increasingly frequent. According to the authors, they appear for various reasons and, therefore, there is a need for the study on pathological manifestations, their different levels, and consequences.

Brito (2017), in turn, states that reinforced concrete structures, when interacting with the external environment, may undergo changes that, over time, cause loss in the structure's ability to support the conditions for which it was designed. These factors directly influence the deterioration of concrete, such as the use of poor-quality material and lack of periodic maintenance. According to the author, despite the evolution of technologies used in civil construction, pathological manifestations in relatively new buildings compromise performance, stability, and functionality.

In this sense, Pontes Junior and Barbosa (2019) present a work that indicates that performance is the behavior in service of each product throughout its useful life, corresponding to how the design, execution, and use of the structure were developed. Moreover, the performance of each material and component can be compromised by external actions, varying according to the level of exposure, even with correct maintenance.

Gonzales et al. (2020) developed an article that presents the main pathologies within the civil construction, such as fissures and cracks caused mainly by foundation settlement, concrete deterioration caused by the loss of cement's binding potential, stains caused by infiltration. The authors aimed to show companies how this affects the quality of the product, leading to customer dissatisfaction problems and unnecessary expenses with post-work assistance.

According to Lima et al. (2017), companies that operate in the construction industry generally prioritize, in the production process of their enterprises, to control their costs, obtain profit, and offer products that meet customer satisfaction. Aiming at the long useful life expected by clients for buildings, it is up to the construction companies to study and apply the best forms of maintenance, done in an effective way in the correction and prevention of pathologies. For the authors, the result will be quality work, which guarantees customer satisfaction and cost reduction.

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2.2. Infiltration and moisture damage

Perhaps the damages caused by humidity and infiltrations are the most common in buildings nowadays. Poor project execution, lack of preparation of professionals, and neglect of natural factors are undoubtedly the main causes of these problems. Although they are primary damages, they can lead to major problems in a building. Infiltration, for example, can result in serious corrosion of the main structure of the building (Machado and Alencar, 2019).

According to Verçosa (1991), moisture in construction represents one of the most difficult problems to correct within civil construction. Moisture in buildings can manifest itself in several ways and has the following origins: brought by capillarity, brought by rain, condensation, and resulting from leaks in hydraulic networks. In accordance with Mason (2020), this moisture that rises from the ground to the underside of the walls, for example, can cause mold, mildew, peeling, and peeling of coating and finishing (paint).

Molds and mildews are caused by plant fungi, which produce acid enzymes that corrode in wood and masonry. The appearance of stains, mold, fungus, and mildew in buildings is largely a consequence of an extension of the infiltration pathology. Machado and Alencar (2019) states that this pathology damages the aesthetic aspect of buildings, characterized by the appearance of dark, yellow or whitish stains, as well as the presence of fungi that promote degeneration of the coating applied.

In this context and according to Yázigi (2003), the frames should meet the requirements of air and water tightness, resistance to uniformly distributed loads and handling operations, and acoustic behavior. Defects in the frames or their placement may generate several pathologies, the most common cases being the manifestations of infiltration in the surroundings.

In a research carried out in São Paulo, Bernardes et al. (1998) presented a distribution of defects in window frames that is intrinsically associated with the occurrence of these pathologies. The results shown by the authors indicate that 23% of the defects are associated with poor sealing, 23% are concentrated in problems in latches and locks, 19% are related to the difficulty in sliding, 17% are concentrated in the gaskets, 12% are related to vibration problems and 7% to the lack of square.

Moch (2009) states the predominance of infiltration in frames occurs in the two opposite horizontal edges: the sill and the lintel.

2.2.1. Infiltrations at sill interfaces

According to Moch (2009), when they occur on the horizontal underside of the sills, the infiltrations predominate at the ends (butt joints). The author states that the putty or plaster and the paint can become deteriorated and discolored, and this occurs because of the poor sealing between the window and the masonry lining, due to the lack of trimming of the sills or the appearance of cracks in the transition area between the window and the sills, through which moisture penetrates.

When there is no barrier to the penetration of moisture on the upper face of the sill, it is common for infiltration to occur along its entire length, which can be aggravated by its inadequate slope. In this sense, an interesting possibility to protect against moisture is the extension of the sill after the vertices are generated with the side faces of the window, in addition to sealing barriers on the upper face of the sill (Moch, 2009).

2.2.2. Infiltrations at lintel interfaces

Infiltration through cracks in the upper edge of the frame (lintel) is also common. This can occur because of poor sealing at the interface, due to the absence or ineffectiveness of some barrier. An unfavorable slope can also drive precipitation into the window instead of away from it.

2.3. Waterproofing

The Brazilian standard NBR 9575 (ABNT, 2010) establishes requirements and recommendations for the selection and design of waterproofing to ensure the minimum permissible and necessary protection to buildings against infiltration and other adversities.

With this objective, the standard defines and characterizes waterproofing projects with graphic and descriptive data. Such projects are subdivided into three stages, namely: preliminary study, basic waterproofing Project, and executive waterproofing project. During the execution of these projects, attention should be paid to critical points, where infiltration cases predominantly reoccur, such as drains, joints, edges, connections, among others.

In a waterproofing system, important information such as hydrostatic pressure, frequency of humidity in the location, insolation, loads, movement, among others, are considered. Briefly and practically, this information is detailed below.

2.3.1. Floor performance and sagging

According to NBR 9575 (ABNT, 2010), the finished floor must have a minimum fall of 1% for the drains. Edges and corners should be rounded or chamfered for better interaction of the surfaces with the waterproofing material, due to smoother angles. The rigidity of the fixation of the drains provides water tightness and allows for the best finish of the waterproofing material.

2.3.2. Drains

According to Righi (2009), drains are among the most susceptible points in waterproofing systems. The finishing of the waterproofing product is done in overlapping and successive layers that can penetrate through the opening. There are appropriate textiles that increase the resistance of liquid waterproofing products and there are also asphalt blankets. The collectors must have diameters larger than the pipes that follow them, with a minimum of 75 mm. The surround of the drain should be lowered to allow for proper installation of the waterproofing layer to the inside of the drain to avoid infiltration of moisture by capillarity.

2.3.3. Baseboards

The NBR 9575 (ABNT, 2010) standard determines that the waterproofing layer must extend along the walls up to a height of 20 cm from the finished floor or up to 10 cm above the maximum level that the water reaches.

To install the waterproofing layer, an indentation is necessary on the surface of the vertical plane (wall) that will receive it. This indentation should be at least 3 cm and extend 20 cm from the finished floor. A galvanized mesh can be installed over the waterproofing layer to help fix it and the coating grout.

2.3.4. Drip

Drip is an artifice in eaves, gutters, platbands, and sills whose purpose is to prevent water from running down the underlying walls and helping to prevent infiltration (Righi, 2009). Its thermal insulation and mechanical protection must be done after the waterproofing.

According to Moraes (2002), "the success of waterproofing depends on a series of details and most water tightness problems are located at critical points, specific singularities for each construction".

Considering the project phase, among the causes of waterproofing problems it is possible to list: absence of a waterproofing project, inadequate materials, poor design of water runoff collectors, interference of other projects with the waterproofing project, among others.

Among the waterproofing problems associated with the execution phase, the following stand out deficiency of the regularization grout, which allows the perforation of the waterproofing layer; the intersection of non-rounded planes (edges and vertices); application of asphalt waterproofing over a humid base, harming adherence and allowing the formation of bubbles, which can cause detachment and rupture of the waterproofing material; lack of cleaning of the base, which affects the adherence of the waterproofing layer; sharp corners in the joints; filling of joints with grout that can be loosened by the action of the mastic; discontinuity in the seams; aggression of the waterproofing layer with trampling, cart traffic and abrasive agents such as sand, for example (Godóy; Barros (1997) apud Moraes, 2002).

Among the pathologies resulting from bad waterproofing, it is possible to mention: the disintegration of grout which, in concrete, starts with a color change, followed by cracking; disintegration of ceramic blocks; efflorescence of salts; dripping; humidity stains; the appearance of vegetation at points of concentration of humidity; and bubbles in the paint.

2.4. Fissures, cracks and crevices

Starting with fissures, which are usually caused by foundation settlement, crushing of construction elements, failure in the design, or poor execution of the structure, one can define them using the term "openings". According to Aecweb (2020), these openings are less than 0.5 mm thick and cause a partial loss of uniformity of solid surfaces, such as structures. The cracks can be passive, where the size of the opening is constant, or active, where their extension increases rapidly. They can appear both in walls and ceilings, but regardless of where they appear, it is important to research and verify their severity so that an immediate treatment and repair procedure can take place.

Speaking about cracks and crevices, Noal (2016) affirms that the difference between fissures is exactly the size and life span. Crack openings can be as small as 1 mm, and cracks a little larger than that, making them more dangerous than cracks. Cracks are among the most important pathologies in masonry. Among the related non-conformities, the most important are compromised service life, water tightness, and thermoacoustic insulation, in addition to the insecurity caused to users regarding structural integrity. Errors in architectural, structural, or foundation projects can generate localized efforts beyond the masonry's admissible, resulting in cracking. The deficiency in communication between the agents that design and execute the masonry justifies these pathologies.

Brandão (2007) identifies execution as the stage of greatest responsibility for the pathologies presented in masonry (22%). Among them, cracks represent 69%. The author considers that the predominant variables related to crack formation, which guide the recovery and preventive maintenance of masonry, are thermal or moisture movement, overload and stress concentration, differential settlement, hydraulic binder shrinkage, and various chemical alterations.

Within this context, Magalhães (2004) specifically investigated cracks in masonry and found that: thermal movement accounts for 31.84%; differential settlement, 27.80%; failure or absence of construction details, 14.35%; structural deformation, 11.66%; shrinkage and expansion, 10.31%; overloading, 2.24%; and various chemical reactions, 1.80%.

Although there is this conceptual difference, the causes and modes of treatment are the same. In reality, the pathologies themselves are the same, what differs one from the other besides the life span and the size is the nomenclature. We can say that they are "less" and "more" dangerous cracks due to these differences, but they are all still cracks.

3. CASE STUDY

Before starting the case study, it is important to bring up some important works that have addressed reforms and analysis of structures in long-stay institutions.

Silva (2016) developed a data collection tool for evaluating the physical structure in long-stay institutions, relating it to the RDC ANVISA No. 283 (Sept 26, 2005). This work is a descriptive-exploratory, field study with quantitative and cross-sectional approach, the research being carried out in a municipality in the state of Para, where the data collection procedure was performed in three steps: observation and mapping the field of study, technical design long-stay institution plant and the data collection procedure. The results obtained by the author show that the professionals are exposed to various physical risks, among which are the insufficient number of professionals, inadequate distribution of furniture and equipment, risk of electric shocks, humidity, noise exposure and inadequacy of space, light and temperature. It was found that the structure of the rated long-stay institution is different from the pre-standards established by RDC ANVISA No. 283/2005, and that the existence of physical risks is a reality; however, according to the author, these problems can be minimized from the mapping of environmental risks, emphasizing that they are preventable and require immediate correction, since they affect the quality of the work done by the professionals.

Alves et al. (2017) conducted descriptive and quantitative research in four Long Staying Institutions for the Elderly in Salvador - Bahia, Brazil, between September and November 2013. Data were collected among the technical managers of the institutions through a questionnaire based on the standards of the National Health Surveillance Agency. The authors evidenced partial compliance with the regulations in force both in the physical-structural and organizational aspects. According to them, the elderly are exposed to an unhealthy environment and risk factors for health problems. The authors concluded that there is a need for adjustments in the institutions to meet the current legislation and highlight the importance of a multidisciplinary team for the comprehensive care of institutionalized elderly people, with emphasis on the role of nursing for the qualification of institutions and valuing of the elder

Finally, Barbosa and Araujo (2014) developed an important research project that aims to study lines of work focused on the humanization of architectural spaces for the elderly. The authors recognize in their research the influence of architecture on human behavior and its contributions to a better quality of life for the elderly, and its applications in social housing projects in low-rise buildings and multifamily residences.

3.1. Building description

The Carlos Romeiro Asylum, the object of study of this document, is located at 341 Vicentinos Street, Conselheiro Lafaiete, Minas Gerais. It is located in a predominantly residential area, with a fully paved road and water, electricity, telephone, and public urban transportation infrastructure.

The asylum is an institution of collective residence for the elderly. Normally, nursing homes are places destined for elderly people who want or need support and protection. In this sense, when it comes to an institution whose main objective is to care for the health, quality of life, and well-being of the elderly, the adaptations of the buildings to human needs and regulatory technical standards are fundamental.

The building's dimensions can be identified through its architectural project, and its main characteristics are described below:

- Reinforced concrete structure with brick and ceramic brick walls; plaster and paint on the inside and outside walls, except for the kitchen and bathroom, with ceramic tiles on the inside. Reinforced concrete slab with no acrylic paint finish;
- Internal floor in a ceramic coating applied over cement and sand mortar subfloor;
- Electrical installations built into the walls with copper wiring; some light fixtures installed, as well as sockets and switches finishing;
- Hydraulic installations with PVC pipes embedded in the walls; ceramic and metal fixtures installed in the bathrooms, kitchen, and service area.

3.2. Local inspections

Like all materials, reinforced concrete degrades over time. The durability of its materials can also be affected by weathering, natural physical, chemical, and biological agents and by unpredictable mechanical actions or overloads. The causes of the deterioration of reinforced concrete, in most circumstances, could be avoided. The pathological manifestations, for the most part, are unique and easily evidenced in the structure. As seen previously, some of the main pathological manifestations that can appear in reinforced concrete structures are cracks and crevices in concrete, reinforcement corrosion, disintegration and disaggregation (concrete slump), concrete wear (abrasion, erosion, and cavitation), efflorescence, and stains on concrete.

In November 2020, still at the beginning of the rainy season, the first technical visit to the nursing home was carried out, in which the need for emergency improvements in the structure of the building was verified. The occurrence of numerous pathologies was observed, the main ones being: infiltration through the floor, walls, and slabs; mold, padding, and peeling paint on the ceiling and walls; pathologies related to the movement of the structure, such as fissures, cracks, and cravices; broken, uneven and uneven floors; and poor air circulation in rooms and living areas.

It is important to point out that these inspections were initial, aiming to get to know the conditions of the shelter better and to structure a project conception for its renovation. Some pathologies not identified in the first visit were verified in the second, such as leaking pipes in the slab, insufficient drainage, disconnected gutters, differential ground settlement in the external area, irregular doors and frames, among others. All these problems can be seen in Figures 1 and 2.

Comparing Figure 1 with Figure 2, it can be seen that the wet regions are the same, even though the images were registered four months apart. In the March 2021 visit, a drip was detected on the water tank outlet pipe (supply), which points to a possible leak in the system, either directly in the tank material, which is visibly deformed, or in the pipe, connections, or special parts (valves, valves, etc.).

Another point to be observed is that, as the slab has no roof and, therefore, is directly exposed to the sun, the pipes are dry and increasing the system's losses, not serving its purpose, which is to supply the water outlets (taps, showers, etc.). In addition, it is not possible to identify in the photos the presence of the thief, necessary piping for situations in which the tap stops working, increasing the chances of a leak occurring. These leaks need to be verified in another inspection but may be responsible for the high values of the asylum's water bills, as reported by its administration.

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Figure 1 – Uncovered slabs, in November 2020. **Source:** Developed by the authors

Figure 2 – Uncovered slab, in March 2021. **Source:** Developed by the authors

In addition, it can be seen from the above images that reinforced concrete slabs and exposed balconies are susceptible to water infiltration through the pores of the material, which leads to other negative consequences, as seen in the following images.

In Figure 3, besides the pathologies to be pointed out in the sequence of this document, the precarious conditions of the bathroom facilities are highlighted, which, although not so visible in the image, are recurrent in all of the building's facilities.

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Figure 3 – Pathologies associated with moisture in exposed slabs. **Source:** Developed by the authors

Also in Figure 3, unpleasant and common occurrences are noted, especially in areas where moisture can enter from the outside or in parts of the building where there is excess moisture: mold, mildew, and peeling. Simply put, mold is caused by excess moisture, which in buildings can be caused by leaking pipes, increased moisture in basements or first floors, damage to the roof, walls, or around window frames.

At this point, it is of concern to point out that according to Lopes (2018), mold and moisture can directly affect health, as moldy areas produce allergens (substances that can cause an allergic reaction), irritants, and sometimes toxic substances. Inhaling or touching mold spores can cause an allergic reaction, such as sneezing, runny nose, red eyes, and skin rashes; they can also cause asthma attacks. Those who live with these problems are more likely to develop respiratory problems, respiratory infections, allergies, or asthma in addition to being able to affect their immune system.

Also according to Lopes (2018), some people are more sensitive to the presence of these pathologies than others and should stay away from moisture and mold, including infants and children;

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elderly people; those with existing skin problems, such as eczema; people with respiratory problems, such as allergies and asthma; those with a weakened immune system.

In Figure 4, as well as in the pictures presented previously, you can see the destruction of the paint, which crumbles and detaches from the surface along with parts of the plaster. In the construction phase, this problem occurs when the paint is applied before the plaster is cured; however, after years of use of the building, it is associated with excessive moisture in the structural and sealing elements.

Figure 4 – Holes in reinforced concrete beams for passage of conduits. **Source:** Developed by the authors

Moreover, among the numerous pathological problems that affect buildings, whether residential, commercial, or institutional, the problem of cracks and fissures is particularly important, due to three fundamental aspects: the warning of a possible dangerous state for the structure, the

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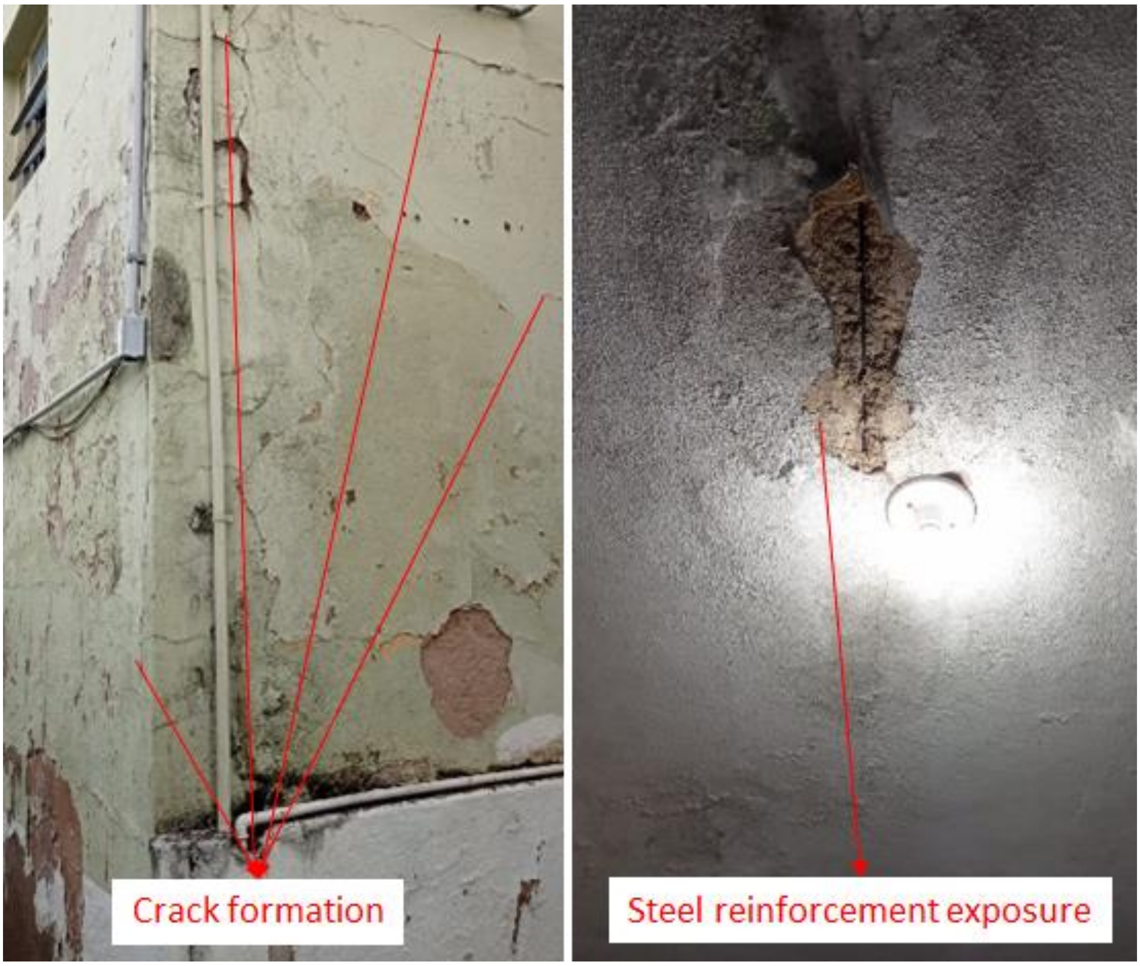
compromising of the building's performance (water tightness, durability, acoustic insulation, etc.) and the psychological embarrassment that cracking exerts on its users.

In this aspect, Figure 5 presents this characteristic pathological manifestation with high occurrence in reinforced concrete structures: cracking. The same figure also shows another recurring problem, the exposure, and corrosion of reinforcement.

Figure 5 – Reinforcement exposure and corrosion. **Source:** Developed by the authors



Always located where there are tensile stresses, the cracks can occur both in the phase in which the concrete is fresh and in the phase in which it is already hardened. It is necessary to know the size of the openings, their extension, and whether they are still moving or have stabilized.

Figure 6 shows yet another pathology found in the facilities of the asylum, the exposure, and corrosion of reinforcement, which is closely related to the opening of cracks. This is a process of material deterioration through chemical and electrochemical oxidation reactions. In other words, the corrosion of steel is its transformation into rust.

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The corrosion of reinforcing steel progresses from the surface of the bar towards its interior, where the gradual replacement of the steel section by rust occurs. Corrosion of reinforcing steel can lead to the appearance of stains in the concrete, but its most serious consequence is related to expansion. The structures most susceptible to corrosion are those that are constantly wetting and drying, especially when the water is contaminated by salts. As in the asylum, the slabs are exposed, their structure also fits in this group of structures more prone to corrosion.

In Figure 6, one can observe the occurrence of pathologies already presented, but with a different origin. This is moisture by capillarity, which rises from the ground and occurs in the foundations of buildings, due to soil conditions. When there are no obstacles, the humidity quickly advances in the walls. It also occurs due to materials that have capillary channels, such as ceramic blocks, concrete, mortar, among others.

Figure 6 – Molds and peeling from soil moisture. **Source:** Developed by the authors

In this context, rising dampness is one of the pathologies that cause dampness in buildings (by capillarity), which can cause various damages, such as

- Stains at the base of the buildings (observed in Figure 7);
- Destruction of coatings, due to the formation of sulfate;
- Formation of mold and mildew (seen in Figure 7);
- Increased heat dispersion from the inside of the building;
- Cold masonry, where condensation phenomena are evident;
- Unhealthy environment;
- Peeling of the coatings due to salt crystallization (observed in Figure 7).

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Figure 7 shows the pathologies described above, but now with an emphasis on the return that occurred within four months, precisely during the rainy season in the region. It is noteworthy that changes in the coatings can impair the performance and basic functions of the building, such as the aesthetic and economic value, the water tightness of the sealant, the regularization, and the finishing of the facade.

Figure 7 – Critical state and in the progressive stage of the building's front façade. **Source:** Developed by the authors

Figure 8 and Figure 9 show the very poor conditions of the roofs of the external area, in which it is possible to see several foci of leaks.

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Figure 8 – Irregularities in the coverage of the outdoor area. Source: Authors

Figure 9 – Pathologies on the platbands and the underside of the slab in the external area. **Source:** Developed by the authors

4. CONCLUSIONS

This work presents a brief literature review on some of the main pathologies caused by infiltration and excess moisture in reinforced concrete buildings, using a case study on the current state of the Carlos Romeiro asylum, in Conselheiro Lafaiete, Minas Gerais.

As can be seen from what has been exposed, the core of most shelter pathologies is the humidity caused by infiltration into the soil, slabs, and walls. Thus, it is essential to intervene in the root cause, aiming at improving the building's performance in the long term, in detriment to actions that are merely palliative. Cover slabs, gutters, and roofs are directly exposed to sun and rain. For this reason, the waterproofing of these areas requires a product that, in addition to being watertight, follows the structure's movements, even resulting from temperature variations, and which also helps in the comfort of the environment, reducing internal temperatures.

Thus, the priority of intervention to repair the pathologies presented above must start from the waterproofing of all exposed concrete slabs. For this, there are two options: installation of a covering and/or application of a waterproofing blanket. Before that, however, it is necessary to inspect all the pipes that are also exposed on the slabs, as they are dry and with possible sources of leaks. Those that are without functionality must be replaced. The watertight condition of the reservoirs must also be checked and the pipes and surface drainage devices must be clean and unobstructed.

All of these interventions are always proposed with the idea that the Carlos Romeiro asylum is an institution for the collective residence of the elderly and that, normally, these are places for elderly people who need support and protection. In this sense, when it comes to an institution whose main objective is to ensure the health, quality of life, and well-being of the elderly, the adaptation of buildings to human needs and regulatory technical standards are fundamental.

REFERENCES

ABNT. **NBR 9575. Impermeabilização**. Rio de Janeiro: Associação Brasileira de Normas Técnicas, 2010.

ABNT. **NBR 15575. Desempenho de edificações habitacionais**. Rio de Janeiro: Associação Brasileira de Normas Técnicas, 2013.

AECWEB. **“Quais são as causas mais comuns de fissuras nas construções?”**. São Paulo: AECWEB, 2020. Available in: https://www.aecweb.com.br/revista/materias/quais-sao-as-causas-mais-comuns-de-fissuras-nas-construcoes/16674.

ALVES, M. B.; MENEZES, M. D. R. D.; FELZEMBURG, R. D. M.; SILVA, V. A. D.; AMARAL, J. B. D. Instituições de longa permanência para idosos: aspectos físico-estruturais e organizacionais. **Escola Anna Nery**, v. 21, n. 4, e20160337, 2017.

RECIMA21 - REVISTA CIENTÍFICA MULTIDISCIPLINAR
ISSN 2675-6218

BARBOSA, E. S.; ARAUJO, E. P. Edifícios e habitações sociais humanizados para idosos. **Universitas: Arquitetura e Comunicação Social**, v. 11, n. 2, 2014.

BERNARDES, C.; ARKIE, A.; FALCÃO, C. M.; KNUDSEN, F.; VANOSSI, G.; BERNARDES, M.; YAOKITI, T. U. "**Qualidade e custo das não conformidades em obras de construção civil**". São Paulo: Pini, 1998.

BRANDÃO, R. M. L. **"Levantamento das manifestações patológicas nas edificações, com até cinco anos de idade, executadas no Estado de Goiás**". Master Thesis, Civil Engineering School, Goiânia: Federal University of Goiás, 2007.

BRASIL. Agência Nacional de Vigilância Sanitária. **Resolução da Diretoria Colegiada RDC 238, de 26 de setembro de 2005**. Aprova o Regulamento Técnico que define as normas de funcionamento para as Instituições de Longa Permanência para Idosos. Brasília (DF): Diário Oficial da República Federativa do Brasil, 2005.

BRITO, T. F. **"Análise de Manifestações Patológicas na Construção Civil pelo Método GUT**: estudo de caso em uma instituição pública de ensino superior". João Pessoa: Universidade Federal da Paraíba (UFPb), 2017.

FERREIRA, J. B.; LOBÃO, V. W. N. (2018), "Manifestações patológicas na construção civil". **Caderno de Graduação - Ciências Exatas e Tecnológicas – UNIT - SERGIPE**, v. 5, n. 1, p. 71, 2018.

GONZALES, F. D.; OLIVEIRA, D. L.; AMARANTE, M. S. (2020), "Patologias na Construção Civil". **Research and Action Journal**, v. 6, n. 1, p. 128-139, 2020.

LIMA, V. N.; LANDIM, G. L.; ROCHA, de M. L. "Causas patológicas na construção civil: Estudo de caso em uma construtora do município de Juazeiro do Norte". *In.:* **XIII International Congress on Pathology and Structural Rehabilitation**, 2017.

LOPES. "**Como o bolor e a umidade em sua casa afetam seu corpo e podem prejudicar sua saúde**". Redação Lopes, 2018. Available in: https://www.lopes.com.br/blog/na-minha-vida/estilo-de-vida/como-o-bolor-e-a-umidade-em-sua-casa-afetam-seu-corpo-e-podem-prejudicar-sua-saude.

MACHADO, K. M.; ALENCAR, E. A. B. " **Levantamento de patologías causadas por umidade nas edificações da cidade de Manaus – AM**". Academic week. North Universtity Center, Manaus: UNINORTE, 2019.

MAGALHÃES, E. F. (2004), "**Fissuras em alvenarias:** configurações típicas e levantamento de incidências no Estado do Rio Grande do Sul*"*. Master Thesis, School of Engineering, Porto Alegre: Federal University of Rio Grande do Sul, 2004.

MASON, E. "**Patologias na construção civil**: quais são as principais?". Belo Horizonte: Mason Equipamentos, 2001. Available in: https://www.masonequipamentos.com.br/blog/patologias-na-construcao-civil/.

MOCH, T. "**Interface esquadria/alvenaria e seu entorno**: análise das manifestações patológicas típicas e proposta de soluções". Master Thesis, School of Engineering, Porto Alegre: Federal University of Rio Grande do Sul, 2001.

RECIMA21 - REVISTA CIENTÍFICA MULTIDISCIPLINAR
ISSN 2675-6218

MORAES, C. R. K. **"Impermeabilização em lajes de cobertura**: levantamento dos principais fatores envolvidos na ocorrência de problemas na cidade de Porto Alegre". Master Thesis, School of Engineering, Porto Alegre: Federal University of Rio Grande do Sul, 2002.

NOAL, B. A. M. "**Entendendo as trincas e fissuras**". Votorantim: Mapa da Obra, 2016. Available in: https://www.mapadaobra.com.br/inovacao/entendendo-as-trincas-e-fissuras/.

PONTES JUNIOR, A. A. S.; BARBOSA, C. F. M. N. "**Levantamento de manifestações patológicas em fachadas**: estudo de caso de um conjunto de edificações residenciais Macapá – AP". Curso de Bacharelado em Engenharia Civil, 2019.

RIGHI, G. V. "**Estudo dos sistemas de impermeabilização**: patologias, prevenções e correções – análise de casos". Master Thesis, School of Engineering, Santa Maria: Federal University of Santa Maria, 2009.

SILVA, D. N. D. O. **Instituto de longa permanência de idosos**: Dimensão físico-estrutural e a potencialidade de riscos e eventos adversos. 2016. Dissertação (Mestrado em Bioengenharia) – Universidade Vale do Paraíba, São José dos Campos, 2016.

TECNOSIL. "**O que é e como ocorre a carbonatação do concreto**". São Paulo: Tecnosil, 2019. Available in: https://www.tecnosilbr.com.br/o-que-e-e-como-ocorre-a-carbonatacao-do-concreto/.

VERÇOZA, E. J. "**Patologia das Edificações**". Porto Alegre: Editora Sagra, 1991.

YÁZIGI, E. "**Civilização urbana, planejamento e turismo: discípulos do amanecer**". São Paulo: Contexto, 2003.