INSPECTION OF PATHOLOGICAL MANIFESTATIONS WITH EXECUTION OF DAMAGE MAP IN FACADES: CASE STUDY IN BLOCK G OF POLYTECHNIC SCHOOL OF PERNAMBUCO

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ABSTRACT
The facades of a building can present more accelerated degradation than the internal parts of a building, as they are constantly exposed to the environment and atmospheric actions, leading to a deterioration throughout its useful life. In view of this, the present research aimed to carry out an inspection to evaluate the current situation of pathological manifestations found in the facades of block G of the Polytechnic School of Pernambuco and elaborate map of their damage. Bibliographical research was carried out through journal articles, books, dissertations and theses in order to address the pathological problems in facades and damage map. Due to the absence of facade plans of the chosen building, a measurement service was carried out using pocket tape and laser tape that served as the basis for the design of the same. Then, the construction of the facade designs was done using AutoCAD software. In addition, surveys were made on the 04 facades of the block that enabled the identification of their pathological manifestations, recorded through a Checklist. Finally, the damage map was created from the data obtained through AutoCAD. It was found that the most recurrent pathological problems were: dirt, cracks, vegetation and detachment of the painting. The damage map proved to be a fundamental tool for the registration of pathological manifestations of a building, as well as for the basis of use for future interventions and/or monitoring of the framework of preservation conditions.

KEYWORDS: *Damage Map, Pathological Manifestation, Facade, University.*

I. INTRODUCTION

Of Greek origin, the word pathology comes from the union of two terms: páthos (disease, suffering) and Logia (science, study). Therefore, pathology can be understood as the study of diseases. This term is used in several areas of study, but with variations of object of study according to the context studied. In civil engineering, in particular, it is used to study symptoms, origins and causes of structure abnormalities [1-2].

Pathological manifestation is the result of a degradation mechanism [3], for example: cracks, stains and mold [4]. In summary, in civil construction, pathology is the general term that studies the pathological manifestations present in constructions [5].

The facades of a building may present a more accelerated degradation than the internal parts of a building, because they are constantly exposed to the environment and the atmospheric actions, leading to a deterioration along its useful life [6-7]. [6,8,9] highlight that the main external factors that influence the facade are: humidity, solar radiation, temperature, rain and wind. The exposure conditions depend on the climatological characteristics of the building's region [10]. In addition, the height of the building can make access difficult, leading to inefficient, or even non-existent maintenance [7] and, as a consequence, the appearance of pathological problems.

The pathological manifestations on facades cause aesthetic discomfort, insecurity for residents, financial problems and devaluation of the property [10-11], in addition to affecting the performance of the facade coating system, compromising its useful life [12-13]. Therefore, it is essential to understand and analyze the pathological problems occurring on facades, in order to mitigate accidents resulting

from such problems [6].
Damage from lack of care with the construction can and should be prevented through preventive planes through a building inspection program, which serves as support to the implementation of the maintenance plan, which aims to ensure the building's good performance, safety, and comfort to users [14].
The damage map is a document used to compile the results of investigations on the state of conservation of a building at a certain moment [15-18] and can be updated positively when the problems have been mitigated or negatively in case of evolution and/or appearance of new pathological manifestations.
The elaboration of a damage map with the information collected helps to better understand the pathological manifestations found [16], besides adding value to the inspection performed [19].
Therefore, this paper aims to perform an inspection to evaluate the current situation of the pathological manifestations found on the facades of block G of the Polytechnic School of Pernambuco and to elaborate damage maps of them.

II. METHODOLOGY

The inspection methodology used was proposed by Castro [20] and Tavares [21], using a checklist for recording the inspected block. The authors divide the inspection process into the following stages: preliminary inspection, detailed inspection, analysis of data obtained and diagnosis. For the photographic record, a camera and a cell phone (iPhone 13) were used.
There were no plans of the facades of block G, so it was necessary to take measurements using a pocket tape measure and a laser tape measure, in order to obtain the necessary data to draw them using AutoCAD software.
After the completion of the facade drawings and the photographic analysis of the pathological manifestations it was possible to represent the damage maps, elaborated through AutoCAD. The graphical representation of colors and hatches was made based on the master's dissertations of Rocha [5] and Barreto [1].

III. RESULTS AND DISCUSSION

The inspection of block G was carried out in June 2022, with several occurrences of rainfall during the day. In conversations with the responsible engineer, it was found that this block had all its blocks painted in April 2020

3.1. FRONT FACADE

The front facade of Block G (Figure 1) gives access to the soil mechanics laboratory and the junior enterprise of the civil engineering course.

Figure 1. Front facade of block G

It was possible to verify dirt on the upper part of the facade in large amounts, although of low In addition, small stains were also observed around the windows, some at the top as seen in Figure 2,

others at the bottom and a more concentrated amount between a window at the bottom of the block that is above the identification sign (figure3).

Figure 2. Dirt on the top of a window of the front facade of block G

Figure 3. Dirt between plate and window of the front *facade of block G*

In some parts of the facade there was detachment of the painting, such as the region between the air conditioning boxes (Figure 4) and on a corner pillar on the extreme right side of the structure (Figure 5).

Figure 4. Paint detachment

Figure 5. Paint detachment on the abutment

In the upper part of the facade there are some openings with some 45º cracks starting at their vertices (Figure 6). This type of crack occurs, according to Thomaz (2020), due to the action of the loads, because of the path of the compression isostatic. Another hypothesis raised by the author is the differentiated settlement due to the lack of homogeneity of the soil.

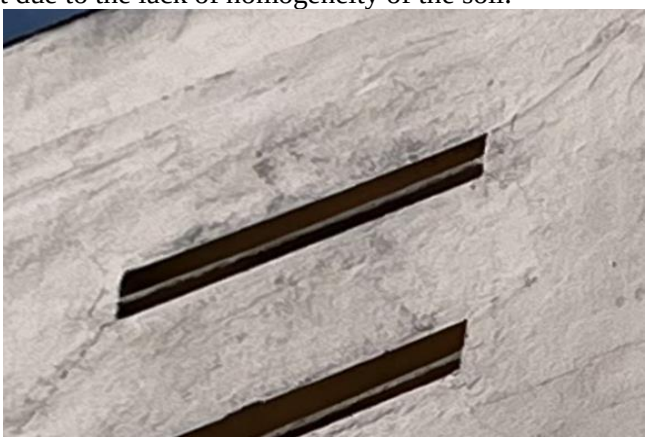

Figure 6. 45º crack in the front facade of the G block

The damage map of the front facade of block G was represented as Figure 7. Although it presents several points of dirt, it is emphasized that the level of dirt is low. It is possible to say that the facade of this block is in good condition, despite having some pathological manifestations. Also noteworthy is the presence of various types of cracks along the facade.

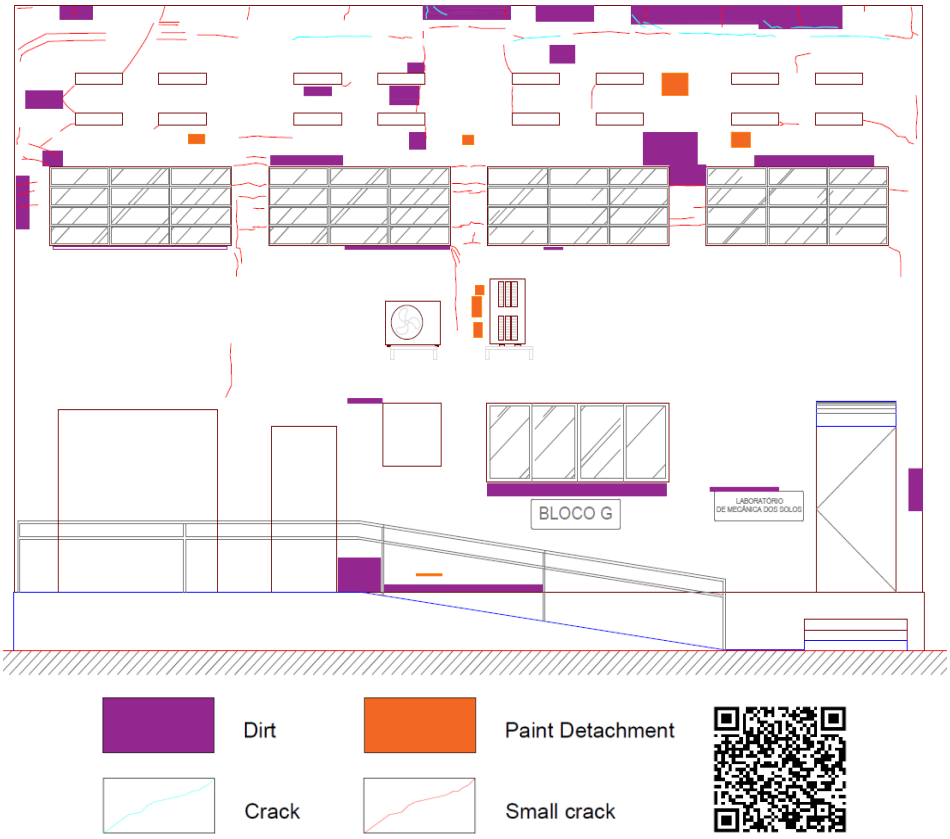

Figure 7. Damage map of the front facade of block G

3.2. RIGHT SIDE FACADE

Figure 8 shows the right side facade of block G, located very close to block F, with only a corridor of just over one meter wide for the passage of people. Due to this restriction, it is worth noting that some photographic records were angled.

Figura 8. Right side facade of block G

This facade presented dirt, mainly on the upper part (Figure 9). In addition, this pathological manifestation was also identified near the left pillar and at the base of the structure.

Figure 9. Dirt on the upper part of the right side facade of block G

In the central region of the facade there is an external pipe that runs from the garden at the bottom to almost the top of the facade. There was dirt around the pipe (Figure 10), probably caused by some leakage at the top.

Figure 10. Dirt on the right side facade of block G

Along the facade, paint detachment was verified, as in Figure 11, which shows the detachment near the left end pillar, and in Figure 12, which shows it near the garden. In addition, other points were verified, seen in the damage map at the end.

Figure 11. Paint detachment on the facade

Figure 12. Paint detachment on the base

A horizontal crack was observed on the upper part of the facade that runs along the entire length of the structure (Figure 13). The crack is above the window, possibly at the structure-masonry interface, between the beam and the masonry.

Figure 13. Horizontal crack that runs along the entire length of the side facade of block G

As on the previous facade, 45% cracks were found in the openings on the upper part of the facade (Figure 14 and 15), some with greater length than others.

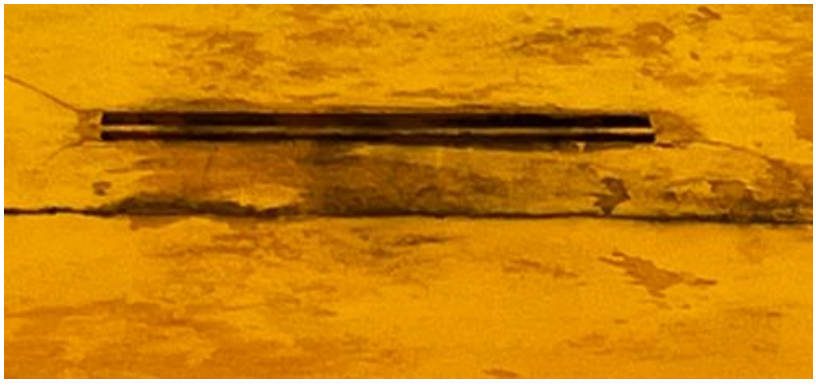

Figure 14. 45º crack in opening in the right side facade of block G

Figure 15. 45º crack in two openings in the right side facade of block G

The damage map of the right side facade of Block G can be seen in Figure 16, which represents the pathological manifestations found. As mentioned previously, this facade has a narrow passage that made photographic records difficult, thus making it difficult to draw up the damage map. Like the front facade, the dirt stains found were mild, with the exception of the region near the central pipe and at the base of the facade. Cracks were found along the facade, especially diagonal cracks found in the openings at the top.

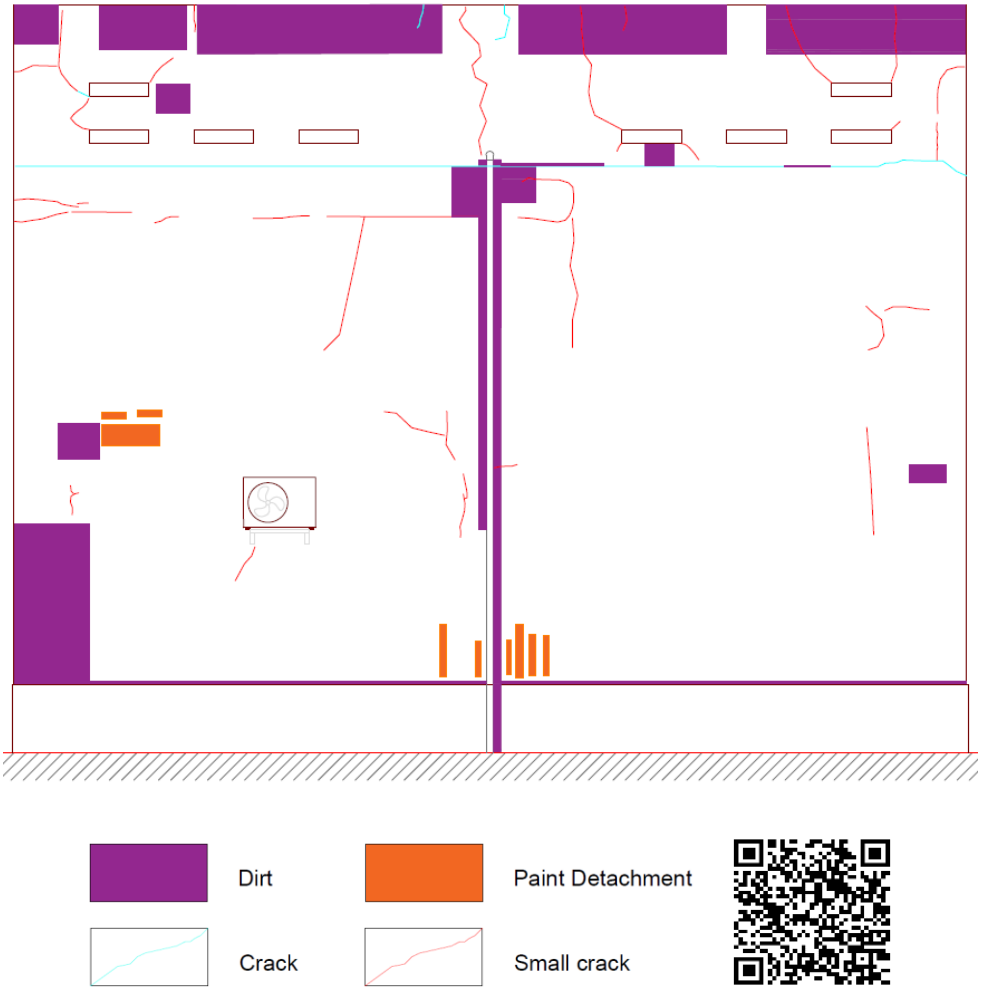

Figure 16. Damage map of the right side facade of block G

3.3. LEFT SIDE FACADE

The left side facade of block G (Figure 17), like the previous facade, has a narrow corridor with block H, making it difficult to take photographs, which were angled due to this condition.

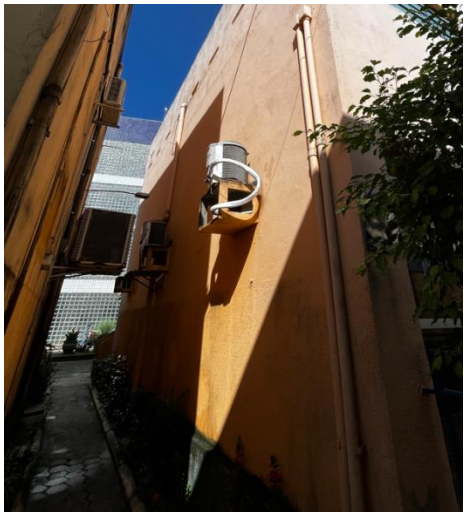

Figure 17. Left side facade of block G

Along the facade it was observed detachment of the paint, especially in some points near the garden (Figure 18), located at the bottom of the facade.

Figure 18. Paintwork detachment on the left lateral facade of block G

It was observed near the garden the action of biodeterioration with the presence of mold and mildew and also the presence of vegetation (Figure 19), although in an early stage. Maintenance is recommended so that the vegetation does not grow and cause future damage.

Figure 19. Vegetation, mold and mildew present on the left side facade of block G

At the top of the facade, horizontal cracks were observed running along its entire length, as seen in the damage map at the end. The ends, both right and left, had an almost 45° inclination of these cracks. It is possible that these cracks occurred at the masonry-structure interface, influenced also by the action of thermal movements that detached the parapet. Figure 20 shows these cracks on the left edge of this facade.

Figure 20. Cracks in the upper part of the left lateral facade of block G

As with the previous facade, several 45° cracks were found in the openings on the upper part of the facade (Figure 21). Due to the difficulty of photographing this facade, it was not possible to obtain many clear images of this problem. However, the damage map depicts all the points that present this pathological manifestation

Figure 21. 45º crack in the left lateral facade of block G

This facade presented dirt spots, mainly in the upper part, but also in some points of the base, as in Figure 22. However, it is noteworthy that the stains were not so dark, presenting low intensity.

Figure 22. Dirt on the left side facade of the block G

The left side facade of block G is in good condition and the pathological manifestations present can be seen in the representation of the damage map (Figure 23). Despite presenting dirt stains all over the upper part of the facade, the level of dirt is not high. It is also noteworthy that this facade did not present as many cracks as the previous facades.

Figure 23. Damage map of the left lateral facade of block G

3.4. REAR FACADE

The posterior facade (Figure 24) does not suffer as much from the action of rainfall, since its upper part has almost no dirt stains. If compared to the previous facades, this one is in excellent condition in relation to this pathological manifestation. However, even so, some detailed points were identified on the damage map.

Figure 24. Rear facade of Block G

Some points were observed where the paint was detached (Figure 25), possibly justified by the fact that this facade has less contact with the action of rain.

Figure 25. Paintwork detachment on the posterior facade of block G

This facade, as well as the other facades of this block, has 45º cracks (Figure 26) in the openings on the upper part, probably formed by the action of loads on the structure.

Figure 26. 45º crack in the rear facade of block G

Some horizontal cracks were observed (Figure 27) at the end of spans, possibly caused by deformation of structural components. According to Thomaz [22], in cases where the masonry is supported on reinforced concrete beams, there is a tendency for cracks to be born in this format and propagate in doorways or windows, where the resistant section of the wall is reduced.

Figure 27. Horizontal cracks at gap ends on the rear facade of block G

There were spaced vertical cracks (Figure 28) in the platbands of this facade, as well as some horizontal cracks. According to Thomaz [22], platbands function as border walls due to their generally elongated shape. The author states that these vertical cracks arise if movement joints have not been conveniently

designed along them. In the case of horizontal cracks, the differentiated thermal movements between the platform and the building body may be one of the possible causes.

Figure 28. Vertical and horizontal cracks on the back facade of block G

Figure 29 shows a crack in one of the window vertices, in which it is almost completely vertical. This type of crack can be caused due to insufficient strength of the block or the mortar itself.

Figure 29. Vertical crack on the posterior face of Block G

Figure 30 represents the damage map of the rear facade of block G. It is highlighted that, as the space is open, it was possible to photographic record the complete facade, making the final design more accurate. Observing Figure 30 it is possible to verify that this was one of the facades less affected by dirt, mainly justified by its location. This facade presented several types of cracks, mainly in the upper region, in the region of the parapet and the openings. In the lower region of the staircase, located on the right part of the drawing, it is possible to see a significant amount of mold, justified by the presence of a garden with some plants on the site

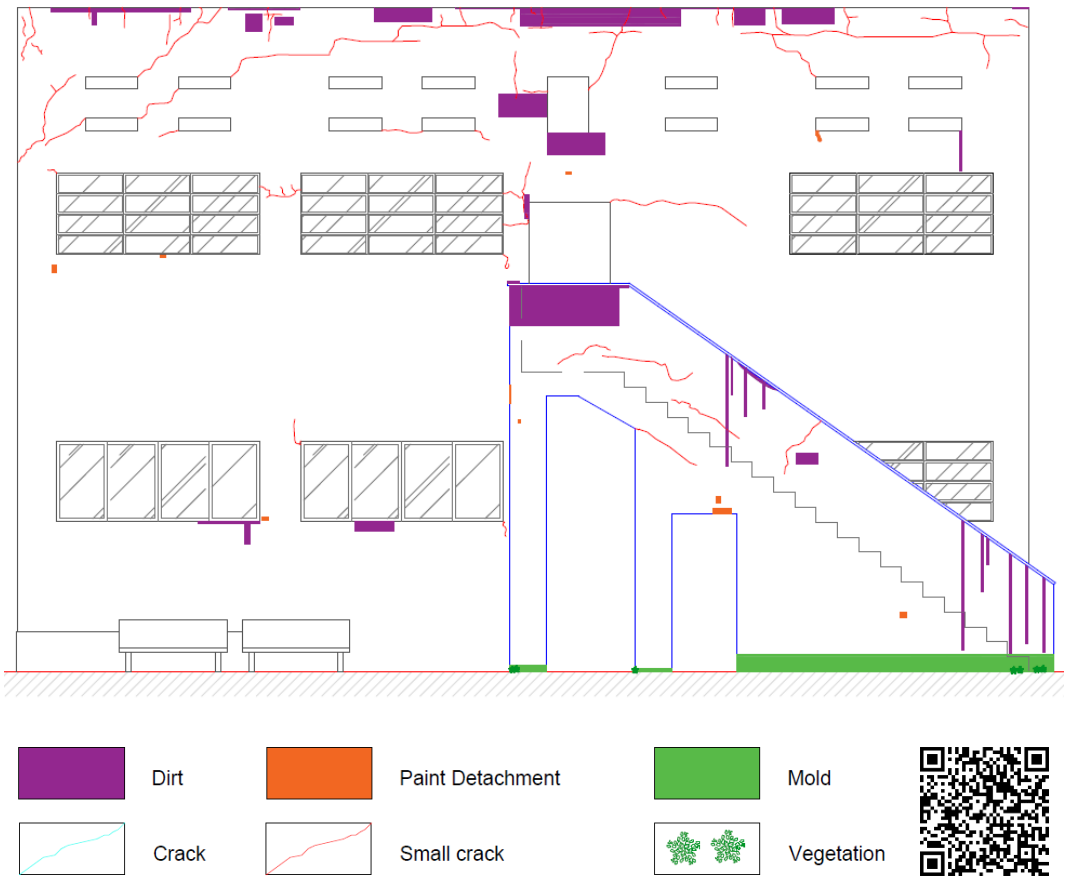

Figure 30. Damage map of the Rear Façade of block G

IV. CONCLUSIONS

Regarding conservation, block G is in good condition, justified by the painting performed on the facades in 2020. It was observed that most of the pathological manifestations found could be mitigated and avoided with periodic maintenance plans.

Among the problems found, dirt was the most recurrent, especially in the upper part of the facades. In addition, other pathological problems that occurred were: cracks, vegetation and detachment of paint.

The damage map proved to be a fundamental tool for the registration of pathological manifestations of a building, as well as for the basis of use for future interventions and/or monitoring of the framework of preservation conditions.

It is necessary to preserve the buildings of a university due to its relevant importance to society. Finally, this research aimed to evaluate the state of conservation of the facades of a block of a university.

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