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RESEARCH ARTICLE

PATHOLOGY IN FLOORS AND CERAMIC TILES: A PRACTICAL APPROACH

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ABSTRACT

The present research deals with the pathologies that happen in the civil construction of floors and ceramic tiles, as well as their causes, preventions and solutions to cure them. The main pathologies of floors and ceramic coatings, whose purpose is to protect the concrete against chemical and mechanical attacks, giving greater ease of cleaning, are delamination, cracks, fissures, efflorescence and deterioration of joints. The damages, in ceramic coatings and floors, are also important from an economic and user satisfaction point of view. The user's concern is usually with the cost of repairing the flooring and also with the unpleasant feeling of being in an environment where the floor is visually damaged and damaged. The objective of the research is to study these pathologies and to present case studies demonstrating the problems and the solutions applied in each case.

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INTRODUCTION

Throughout the lifetime of civil constructions, there are maintenance and rehabilitation concerns (general reforms), and the ceramic claddings on facades and floors are the components that deserve special care, since, floors and facades are usually exposed the degradation mechanisms and also, are the most aesthetically shown areas of the works (CHAVES, 2009). Second Chaves (2009), it is common to observe a greater effort to improve the quality of construction, however, often in recent works, there is a diversified appearance of pathological manifestations. These pathologies occur for several reasons, and often the evolution of the technology of treatment and creation of new materials does not accompany various intervention agents in the construction sector. Masonry walls, for example, have a relevant role in civil construction and have the potential to satisfy the functional requirements that correspond to them. However, it is apparent to the dissatisfaction of many users with regard to defects in these walls, with repercussions on the safety, comfort and health of the day to day (Da SILVA, 2002). According to Verçosa (1991), the constructive characteristics favour the emergence of pathologies in buildings, due to the constructions being carried out seeking the maximum economy and the lowest time of execution. Klein (1999) also cites the poor quality of labor, responsible for many of the pathologies verified.

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According to this author, the lifetime of a construction is related to the correct planning during the execution phase. Equally important are the care in the design and maintenance phases. According to Canovas (1988), the pathology of constructions is not regarded as modern, even though such pathological problems arose recently. The presence of problems in the houses constructed by primitive man were already reported. Having a knowledge of the pathology of buildings is indispensable for all civil construction workers, from a worker to the engineer. Second Verçosa (1991), cited by Souza (2008), when you know the causes of pathological problems, the chance of making mistakes greatly reduces. The author cited further mentions that this knowledge is as important as the greater the professional responsibility in construction of the work. What happens is that often, in the realization of the projects, or in the forced reduction of the time of execution of the works, or also in the little preparation of the designers and the labor, do not take the due care to ensure that future defects occur, that is, it is common that in works the agents responsible for the construction itself, do their tasks in irregular shapes, as shown in the image below, workers without safety equipment, without guidance of engineering projects and without supervision (CHAVES, 2009). In the technical medium there is an acceptance of the importance of analyses and diagnostics aimed at identifying pathologies in construction elements, thus enabling the choice of the best solution. This acceptance is based on a conception, or understanding, where the results are faced with the elaboration of a model of behavior. It is then demanding a vast and rigorous gathering of information as well as a long and

solid professional experience of the responsible involved (CABRITA, *et al*., 1998). In this way, it is noted that the correct identification of the causes and the rigorous evaluation of the situation is a mandatory condition for the resolution of pathologies. In these analyses it is necessary to avoid extreme positions, i.e. excessive optimism or excessive pessimism. A very optimistic assessment of the state and character of pathologies in construction elements can lead to the potential loss of security and economy in the medium/long term. The position of excessive pessimism can lead to the depletion of resources (CABRITA, *et al*., 1998). In this case, the focus of this research is to demonstrate the causes of existing pathologies, reinforcing the study and disseminating the solutions of these problems for future engineers.

Types of pathologies on facades and floors

For Chaves (2009), floor pathologies are caused by similar effects to the facades. These effects were classified in four types, they are:

- **Initials** – are those coming from the project phase, depending on the failure to comply with the technical norms, or the carelessness and omissions of designers, which result in errors in detail and inadequate conception of the coatings. This error is responsible for most of the pathologies registered in buildings.
- **Constructive** – Its origin is associated with the execution phase of the work, coming from several factors such as: non-certified products; Techniques and materials employed incorrectly by the absence of a method of settling parts. This phase is also responsible for a large part of the anomalies in buildings.
- **Acquired** – are those that happen during the lifetime of coatings. Coming from the exposure of floors and facades to weatherproof, aggressiveness of the medium with excessive loads, chemicals and inappropriate maintenance, damaging the layers and unleashing the pathology.
- **Accidents** – are those that occur due to an atypical event, resulting from exceptional action, such as winds of higher intensity than normal and even fires. Causing unpredictable efforts, particularly in the base layer and on the joints, causing displacements of the parts, and unleashing pathological processes in jail.

Main pathologies on ceramic floors and flooring

The most relevant types of pathologies occurring in ceramic finishes are: detachments or displacements, fissures, cracks, cracks, efflorescence and deterioration of joints.

Delamination or detachments

According to Barros *et al*. (1997), cited by Rhod (2011), the detachments are caused by the loss of adhesion between the layers of the ceramic coating, or between the base and the substrate (structure, masonry) of the substrate. Occurs when the tensions arising in the ceramic coating are superior to the adhesion capacity of the bindings between the mortar and the ceramic plate. According to a Campante (2003), a signal that may indicate a detachment is the occurrence of a sound dig (hollow) on the ceramic plates when impacted or the finishing layer stew. This pathology occurs in the first and last floors of the building due to the high level of tensions present in these places, as shown in Figure 1.

Source: Júnior, 2017.

Figure 1. Detachment of ceramic coating on external facades

Cracks, fissures and crevices

The NBR 9575 (ABNT, 2010), which refers to waterproofing, selection and design, identifies the gaps between 0.5 mm and 1 mm as cracked, the gaps between 0.05 mm and 0.5 mm are called fissures and smaller than 0.05 mm are classified as micro fissures. The NBR 13818 (ABNT, 1997), referring to the specification and methods of testing on ceramic plates for coatings, classifying the cracks in a series of apertures below 1 mm that succeed on the enameled surface of the plates, giving it a spider's web appearance, as Figure 2.

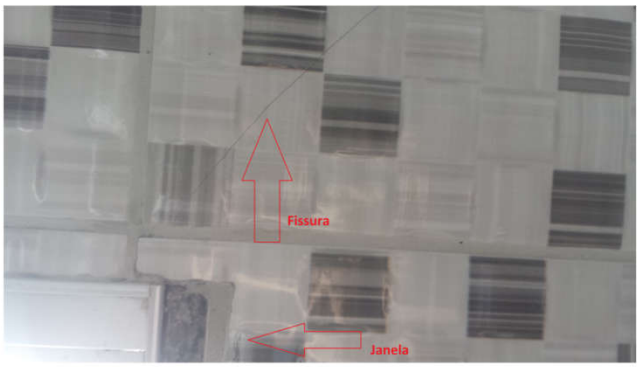
Source: NBR 13818 (ABNT,1997)

According to Thomaz (1989), the emergence of cracks and fissures is aggregated to the following phenomena:

- Thermal movements: Occurs when there is a variation of temperature or humidity, generating internal tensions that, if they exceed the threshold of resistance of the plate, cause cracks and fissures. When tensions reach the enameled layer of the plate, the cracks occur.
- Excessive deformability of the structures: creates tensions that are transmitted to the masonry and for the coating causing the cracks, fissures and cracks, as shown in Figure 3.
- Retraction of cement-based products: Occurs when the mortar is dosed in the work causing retraction by the loss of kneading water, with consequent onset of cracks, fissures and cracks.
- Absence of constructive details: bends and bends in the openings of the windows and doors help to disperse tensions that reach the coatings, reducing the likelihood of occurrence of cracks and fissures, as shown in figure 4
- Cracks, fissures and cracking may also occur by chemical alterations of materials, foundation differential redecals or foundation movements.

Source: Authors' collection, 2017.

Figure 3. Broken due to excessive deformability



Source: Authors' collection, 2017.

Figure 4. Fissure due to absence of constructive details

Efflorescence

According to Gonçalves (2007), the efflorescence are crystalline deposits of whitish color, formed inside and on the surface of the masonry panels through crystallization of saline solutions. These deposits arise as a result of the evaporation process or temperature variation, usually accompanying the presence of moisture. These salts in contact with the air, solidify, forming deposits.

According to Barros et al. (1997), to prevent efflorescence, it should be performed correctly and take some precautions:

- Reducing the consumption of Portland cement in settling mortar;
- Use of quality guaranteed ceramic components and free of residual moisture;
- Ensuring the time required for complete drying of each coating layer;
- Use hydrochloric acid at low concentrations during coating cleaning.

Deterioration of joints

According to junior (2017), this pathology happens when there is a loss of tightness of joints, due to improper cleaning procedures and aging of the grouting mortar. The deterioration of the joints between ceramic plates is occurring. The result of the deterioration of the joints compromises the ceramic coating as a whole, may arise cracks and fissures, seepage, efflorescence and even displacement of the plates (JUNIOR, 2017).

Diagnoses and discussions

In order to better demonstrate some pathologies on ceramic floors and finishes, a photographic observation of buildings in the metropolitan Region of Belo Horizonte/Brazil has pathological problems.

Edification I

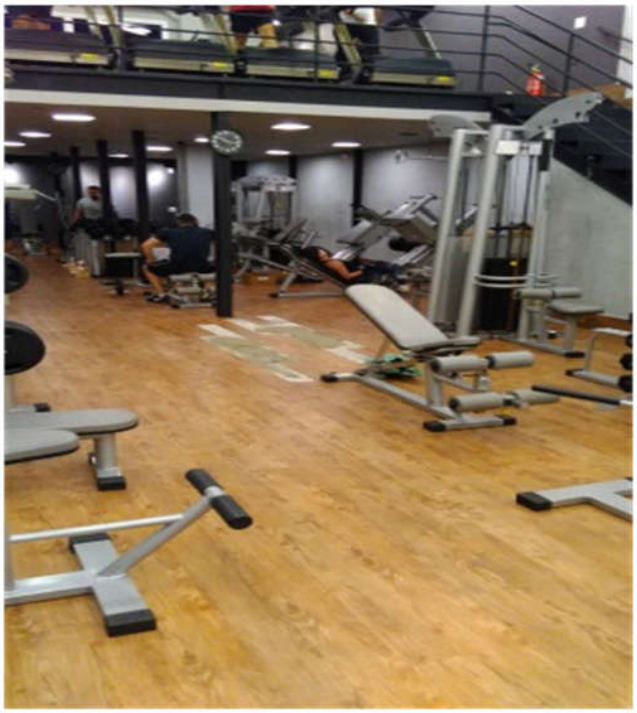
This case occurred on the floor of the gym Happinnes Fit, located at a mall in the municipality of Contagem/Brazil.

Description of pathology

Discarding of the laminated hardwood floors of the gym. As Figures 5 and 6.

Source: Authors' collection, 2017.

Figure 5. Displacement of the gym floor



Source: Authors' collection, 2017.

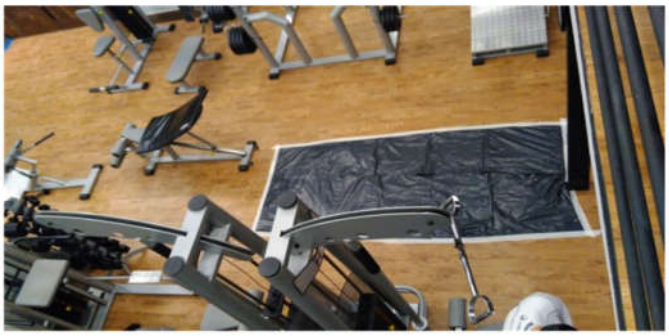
Figure 6. Displacement of the gym floor

Hypothesis of possible causes

The hypothesis of possible causes were not conducted through visual inquiry and rather with a conversation with the owner of the academy. According to the owner, the floor plates with dimensions of (20x90) cm, are very long, so the weights of the academy when placed on a tip of the floor, ended up causing the lifting of the other end. That made those plates loose. The owner reported that the gym weights accidentally fall on those plates, which helped cause the pathology.

Repair proposal

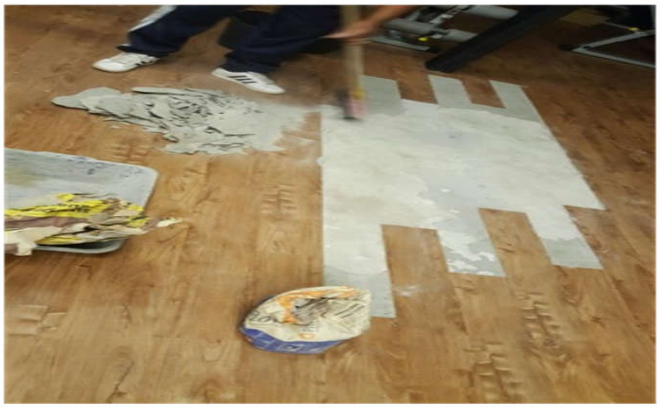
According to the owner of the establishment, the pathology was covered with a canvas so that the academy could work during its working hours, the protection occurred only for users ' safety, as shown in Figure 7. Maintenance and repair works were made on the night shift.



Source: Authors' collection, 2017

Figure 7. Spreading the pathology with a canvas

The removal of the plates that were close to those which were discarding, in the aftermath, was carried out cleaning the area (Figure 8).



Source: Authors' collection, 2017

Figure 8. Cleaning the site after removing the plates

For repair, the industrialized mortar (AC II) adhesive was used. Observing the moisture content of the work piece to be seated and the dosage of mortar not to occur other pathologies. After maintenance, the floor is ready again, as shown in figure 9.

Source: Authors' collection, 2017

Figure 9. Academy floor restored

Prevention proposal

Use of a rubberized floor for environments where excessive loads is predominant, which would contribute to the absorption of tensions from any eventual impact.

Edification II

This case occurred in a building in the city of Belo Horizonte/Brazil, where there was observed a pathology in the ceramic coating.

Description of Pathology

As shown in figure 10, the pathology observed is characterized, according to NBR 9575 (ABNT, 2010), as broken, as its aperture is greater than 0.5 mm and less than 1 mm.

Source: Authors' collection, 2017

Figure 10. Crack observed in an inner door of the building

Hypothesis of Causes

For the formation of cracks can be considered several factors, in which it may be included: excess loads from coverage, thermal dilation and absence of constructive details. According to residents of this building, the execution phase was very troubled due to the responsible engineer, omitting constructive details at the project stage, causing the building to have a series of pathologies, among those, the observed in the coating. Ceramic. Such an argument can be convincing because, according to Thomaz (1989), the absence of constructive details such as bends and bends in the doors and windows, cause cracks, fissures and cracks. Other hypothesis for a possible cause of pathology would be the thermal movement of the mortar coating and the differential repression of the foundation.

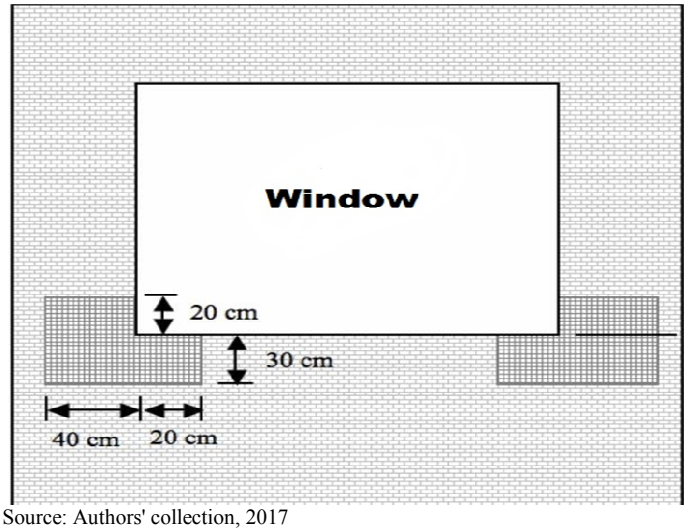
Repair proposal

For selecting the correct broken recovery process observed in this building, it is necessary to remove the affected ceramic coating, make a gap of the cracks in the masonry, followed by cleaning and subsequently applying a flexible product, such as an elastic sealant. Shortly after, replacing the affected part with another and taking it, probably presenting a satisfactory outcome. According to Junior (2017), the opening of vertical drive joints every 3 m or at each right foot is also of great importance.

Prevention proposal

Observing the requirements of the current technical norms when designing the building, avoids errors during the

execution phase, reflecting on the proper functioning of the structure as a whole, including ceramic finishes. There are also the norms that specify the technical characteristics of the components of the ceramic coating, assisting in the implementation of a detailed project and theoretically based on its technical aspects. This process is essential for the good performance of the ceramic coating, although it is not sufficient, it is the primordial. It is up to the coating designer to know and analyze the products with which he works and specify them in a correct way (ROSCOE, 2008). Second junior (2017), the correct execution of moving joints would decrease the incidence of pathologies. The use of polyester screens in door and window corners would be an option for the treatment of pathologies, as shown in Figure 11.



Source: Authors' collection, 2017

Figure 11. Treatment of cracks and fissures in doors and windows with polyester fabrics

Conclusion

Pathologies can be caused in the three phases: project, execution and maintenance, the latter, in which the problem is already known. The main reasons for the occurrence of pathologies are: low-quality materials and lack of detailing in the three phases, mainly in the execution, where pathology can start. However, as pathologies are "common" in buildings, they can be avoided, from more detailed studies of how to avoid them and when the same occurs, investigate their possible causes to deploy the best solution to Cairns it. A thorough follow-up in the three phases is needed to then minimize the chance to get the problem.

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