

**PATHOLOGICAL MANIFESTATION IN INTERNAL CERAMIC COATING: A
CASE STUDY IN A BUILDING IN GOIÂNIA-GO**

**MANIFESTAÇÃO PATOLÓGICA EM REVESTIMENTO CERÂMICO INTERNO,
ESTUDO DE CASO EM UMA EDIFICAÇÃO EM GOIÂNIA-GO**

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ABSTRACT

Ceramic coatings are a hallmark of Brazilian construction culture, enhancing buildings with their aesthetic impact and being widely used in the national context for several decades. The appropriate selection of materials, combined with precise application processes, directly reflects on the durability and longevity of buildings. This study emphasizes that specialized knowledge not only in the selection and application of coatings, but also in the identification and understanding of possible failures, is a key factor in preventing future problems. The relationship between the individual characteristics of materials, installation methods, and exposure to environmental conditions is crucial to avoid pathologies such as detachment, which may compromise structural stability. Therefore, by deepening the analysis of ceramic coatings and presenting a case study that illustrates these concepts, this work contributes to improving the understanding of coating systems and to the continuous evolution of construction practices in the national scenario, promoting more resilient and durable buildings for the future of Brazilian construction.

Keywords: Ceramic Coating. Building Pathology. Detachment. Building Performance. Construction Quality.

RESUMO

Os revestimentos cerâmicos são uma marca na cultura construtiva brasileira, valorizando as edificações com seu impacto estético, sendo utilizados no cenário nacional por várias

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décadas. A escolha adequada dos materiais, aliada a processos de aplicação precisos refletem diretamente na resistência e longevidade das edificações. Este estudo enfatiza que o conhecimento especializado não apenas na seleção e aplicação dos revestimentos, mas também na identificação e compreensão das possíveis falhas, é um fator preponderante para impedir problemas futuros. A conexão entre as características individuais dos materiais, os métodos de instalação e a exposição às condições ambientais é crucial para evitar patologias como o deslocamento, que pode comprometer a estabilidade das estruturas. Assim, ao aprofundar-se na análise dos revestimentos cerâmicos e ao oferecer um estudo de caso que ilustra esses conceitos, este trabalho contribui para aprimorar não apenas a compreensão dos sistemas de revestimento, mas também para a contínua evolução das práticas construtivas no cenário nacional, promovendo edificações mais resilientes e duráveis para o futuro da construção brasileira.

Palavras-chave: Revestimento Cerâmico. Patologia das Construções. Deslocamento. Desempenho das Edificações. Qualidade Construtiva.

RESUMEN

Los revestimientos cerámicos son una característica destacada de la cultura constructiva brasileña, valorizando las edificaciones por su impacto estético y siendo utilizados en el contexto nacional durante varias décadas. La adecuada elección de los materiales, combinada con procesos de aplicación precisos, se refleja directamente en la resistencia y longevidad de las edificaciones. Este estudio destaca que el conocimiento especializado no solo en la selección y aplicación de los revestimientos, sino también en la identificación y comprensión de las posibles fallas, es un factor fundamental para prevenir problemas futuros. La relación entre las características individuales de los materiales, los métodos de instalación y la exposición a las condiciones ambientales es crucial para evitar patologías como el desprendimiento, que puede comprometer la estabilidad de las estructuras. Así, al profundizar en el análisis de los revestimientos cerámicos y presentar un estudio de caso que ilustra estos conceptos, este trabajo contribuye a mejorar la comprensión de los sistemas de revestimiento y a la evolución continua de las prácticas constructivas en el contexto nacional, promoviendo edificaciones más resilientes y duraderas para el futuro de la construcción brasileña.

Palabras clave: Revestimiento Cerámico. Patología de las Construcciones. Desprendimiento. Desempeño de Edificaciones. Calidad Constructiva.

1 INTRODUCTION

Civil construction plays a crucial role in Brazil's economic development, generating a large number of jobs. According to the Brazilian Chamber of the Construction Industry (CBIC, 2023), the sector will continue to grow in 2023, with the expectation of a growth of 2.5%, being the third consecutive year of growth in this market.

In the context of this scenario, it is important to acquire knowledge about the materials applied in civil construction, in order to facilitate the appropriate choice of their various applications and define their properties and technological qualities. In addition, it is essential to know the construction techniques available in the market, so that there is greater training of the professionals involved, and enabling the choice of the best actions that fit into each project and execution of civil works (CALLISTER, 2002). In this context, a problem that can be pointed out is the construction defects that cause pathologies in buildings. In this work, the causes and actions necessary to treat recurrent pathologies in ceramic tiles will be discussed.

In turn, ceramic tiles are widely used in civil construction due to their durability, surface resistance, cost-effectiveness and designs, playing a fundamental role in the final finish of a project, influencing aesthetics and the whole as a whole. However, even with good durability, ceramic pieces are subject to environmental and use factors, which can result in the emergence of pathologies (ANFACER, 2021).

Detachment, cracking, cracking, efflorescence and deterioration of joints are pathologies that can occur in ceramic tiles in indoor and outdoor environments. These defects can manifest themselves in the first years after the delivery of the work due to construction failures and vices, inadequate projects and planning errors. To avoid these pathologies, it is essential to have qualified labor and follow proper planning. In addition, it is essential to carry out regular maintenance of the coatings, to extend their useful life (ESTEVEZ, 2020).

A common pathology in ceramic tiles is the detachment of the pieces, which occurs when the pieces come loose or detach from the substrate. This can result in swelling of the coating, cracking, or even complete removal of the coating. Therefore, to treat problems in ceramic tiles, it is essential to carefully analyze each situation, considering the type of ceramic, place of use, environmental conditions, and specific problems. Based on this analysis, it is possible to develop restoration solutions adapted to the needs of the affected coating, ensuring its preservation and performance (PARREIRA, 2017).

Based on the information mentioned above, the detachment of the ceramic tile in the Porto Dourado Residential condominium, Goiânia-GO, was identified, where a case study was carried out, raising the possible causes for the appearance of pathologies after the

completion of the work.

A detailed analysis of the problem, an on-site evaluation to identify the possible causes and a literature review were carried out, in order to find possible solutions for the detachment of the ceramic tile. These resolutions may involve choosing the correct bonding binder, reviewing the executive methods of laying, and performing proper maintenance.

2 THEORETICAL FRAMEWORK

In the literature review, the history of ceramics, its manufacture and properties will be addressed. As well as ceramic pathology, emphasizing the flaws, especially the ceramic detachment. Finally, executive methods and the types of mortar used to prevent these problems, highlighting their importance in the durability and performance of the material.

2.1 HISTORY AND CHARACTERIZATION OF CERAMIC MATERIALS

The first ceramics appeared in the middle of 500 BC, remaining a difficult material to access for several centuries due to its high cost and for being an innovation. The greatest advances in the area were incorporated by Italian potters between the 1950s and 1960s, introducing innovative production processes. Potters exploited the Raku method, introducing fast firing and harsh cooling for unique effects. There was a shift to contemporary ceramics, focusing on unconventional forms and sculptures. In addition, innovations in enamels allowed for vibrant colors and unique textures, revitalizing ceramics as a form of artistic expression.

Ceramics are made up of inorganic materials and chemicals, excluding metals and their alloys, which are usually produced through heat treatment at high temperatures (ABCERAM, 2004). Ceramic materials are known for their unique properties, such as hardness, resistance to high temperatures, low electrical and thermal conductivity, high chemical resistance, and good wear resistance. These properties make them useful in a wide range of applications, such as in the manufacture of traditional ceramics, advanced ceramics, glass, refractories, electrical insulators, catalysts, biomaterials, and many others. Traditional ceramics, such as clay and porcelain ceramics, are widely used in everyday products such as dinnerware, tiles, and bricks. Advanced ceramics, on the other hand, are high-tech materials with inscribed properties applied in sectors such as electronics, energy, aerospace, automotive, medical and chemical (SILVA, 2005).

It is important to note that ceramic materials are not necessarily resistant, as they are often associated, but they can have high mechanical resistance when designed and industrialized correctly. In addition, they offer advantages such as chemical stability, low density, and excellent performance in indoor and outdoor environments (CARVALHO, 2012).

2.2 CERAMIC COATING

Ceramic coating, used to cover floor and wall surfaces in indoor and outdoor spaces, is a versatile material, made from raw materials such as clay, feldspar and quartz, molded into plates and fired at high temperatures to provide strength and impermeability. It offers a wide variety of colors, textures, and prints, mimicking other materials such as wood, stone, and metal, making it a popular choice for homes, offices, hospitals, and other high-traffic environments (SABATTINI, 2000). Their advantages include easy cleaning, wear resistance, durability, and low water absorption, but disadvantages can arise such as cracks, breakage when exposed to severe impacts, the need for careful installation, and potential difficulty in replacing them if they become damaged, requiring professional installation to avoid irregularities (NUNES et al., 2015). In short, ceramic tiles combine beauty, practicality and resistance in different spaces.

2.3 MANUFACTURE OF CERAMIC COATING

The useful life of a building is the period in which it can be used for the purpose for which it was built, with satisfactory performance in terms of safety, comfort and functionality. The useful life of a building can vary depending on several factors, such as the type of use, the design, the quality of the materials, and proper maintenance.

Standard $\sqrt{}$. 15575 (ABNT, 2013) establishes the minimum requirements for the performance of residential buildings, including the minimum expected useful life, which is 50 years. However, it is important to note that the useful life of a building can be longer or shorter than the expectation established by the standard, depending on several factors, such as the level of use, the quality of the materials, the climate, and proper maintenance. Proper and preventive maintenance can significantly extend the useful life of a building, while lack of maintenance can accelerate degradation and reduce its useful time.

2.4 PROPERTIES OF CERAMIC PLATES

Ceramic tiles for coating have characteristics determined by their properties, and through this understanding we can make specifications for their proper use.

2.4.1 Water absorption

Water absorption in ceramic tiles is an important property to consider, and is linked to their porosity, when choosing a coating for wet areas such as bathrooms, kitchens, and outdoor areas. It is measured by the amount of water that a ceramic material absorbs in relation to its weight. Coatings are classified into different water absorption groups according

to technical norms and industry standards. These ratings usually vary depending on the percentage of water in the material. The lower the percentage of water absorption, the greater its resistance to water penetration (MADEIRA, 2019).

In addition, the absorption of the ceramic allows the analysis of the type of mortar that should be used for each installation. In this way, it is clear that the proper laying of the piece depends on the assertive use of the mortar, ensuring durability and resistance, increasing the useful life of the piece.

2.4.2 Hardness

Another important property of ceramic tile is hardness, which refers to the material's resistance to deformation, scratches, or abrasion. It is a mechanical property that determines the ability of ceramics to withstand loads and resist wear and tear (MACEA, 2018).

There are several hardness scales for measuring the strength of materials, with the Mohs scale, created in 1812 by Friedrich Mohs, focusing on natural minerals, and the Vickers hardness scale, created in 1921 by Smith & Sandland in Great Britain, being more appropriate for ceramics and hard materials. The Mohs scale ranges from 1 to 10, rating the hardness of minerals. However, for ceramics, the Vickers scale is preferred, involving a specific load applied to a given area, measuring the resulting impression (HOTZA at al, 2015).

The hardness of ceramics varies considerably, with aluminum oxide, silicon carbide, and silicon nitride being examples of ceramics notable for their high hardness and wear resistance. However, when choosing a ceramic, it is crucial to consider not only hardness but also properties such as fracture resistance, toughness, and chemical resistance, according to the specific needs of the application (HOTZA at al, 2015).

2.4.3 Surface abrasion resistance

The ability to resist surface wear caused by contact with people and objects is related to abrasion resistance. This resistance can be divided into two types: surface abrasion, which occurs in enameled products, and deep abrasion, which affects non-enameled products. The Porcelain Abrasion Index (PEI), is an abrasion resistance rating system used to evaluate the durability of ceramic tiles on floors and walls. It provides information on the abrasion resistance of ceramic surfaces, classifying them according to their ability to withstand wear. The measurement of abrasion itself involves specific tests, which assess the loss of material due to deterioration (NUNES at al, 2015).

2.5 CONCEPT OF PATHOLOGY

Pathology in ceramic tile refers to problems or defects that may arise during the installation, use, or maintenance of ceramic coated floors, walls, or other surfaces. These problems can be caused by various factors, such as problems in the manufacturing process of materials, failures in the installation process, or even improper use, or lack of maintenance (DOUGLAS et al., 2017).

One of the main factors that can lead to pathology in ceramic tiles is the poor quality of the substrates on which the tile is applied. If the substrate has irregularities, cracks or deformations, this can compromise the adhesion and stability of the coating, which can lead to cracks, detachments and other types of defects (LANNA, 2012).

Another factor that can contribute to pathology in ceramic tiles is the lack of planning and efficiency of the installation process. The choice of adhesive, for example, can affect the adhesion of the coating and compromise its durability. Likewise, the lack of care in the handling and transportation of the pieces can lead to damage that will later manifest itself in the form of defects (LANNA, 2012).

In addition, the choice of the type of ceramic tile can also have an impact on the occurrence of pathologies. For example, low-quality ceramic tiles can have cracks, peeling, and other defects even when installed correctly, while high-quality and high-strength tiles can perform better in harsh conditions.

2.6 FAILURES

There are several types of failures that can occur in ceramic tiles, and their occurrence can be influenced by a number of factors, such as the quality of the substrates, the installation process, the type of coating used, among others. According to DOUGLAS at al (2017), some of the most common types of flaws found in ceramic tiles are listed.

Design or design failure: design failures in ceramic tiles can occur for various reasons, including miscalculation, external specifications, or lack of consideration of environmental conditions, and can happen in the planning part, especially in the lack of project compatibility.

Execution failure: they can be attributed to problems in the substrate, such as its inadequacy, which can result in detachment, cracks or breaks in the floor. It is essential to check and correct problems on the substrate, including removing damaged flooring if necessary. Another common failure involves poor adhesion of the mortar, which can lead to peeling and cracking. Therefore, ensuring clean and appropriate substrates for ceramics, as well as choosing the appropriate mortar, is critical. The fixation of ceramic pieces is also

critical; An even application of mortar and proper pressure during installation are essential to avoid detachment or voids. Using spacers can help maintain proper spacing between parts.

Failure of use: this type of failure occurs mainly because the user of the product does not have the necessary knowledge for the correct use of the material, and ends up resulting in misuse of it, generating several pathologies.

2.7 PEELING OFF THE CERAMIC COATING

Ceramic tile peeling occurs when the ceramic tile detaches from the base where it was laid, as shown in figures 1 and 2. This problem can be caused by several factors, such as lack of adhesion of the mortar used in laying, as the surface that will receive the mortar must be clean, free of dust, dirt, oils or other contaminants, if the surface is not properly prepared, the adhesion of the mortar can be compromised. There is also the absence of leveling of the base, which can affect the direction of the mortar, since when the base is not level, there may be empty spaces between the mortar and the surface, which reduces adhesion, this can occur in several situations, one of them being the irregular surface, since if the surface where the mortar is applied has irregularities, such as ripples, holes or bumps, this can also affect the adhesion of the mortar.

For this reason, it is important to level the surface before applying the mortar, using appropriate techniques and materials for each specific case. Finally, there is excess moisture, which, like the other reasons, also compromises the adhesion of the mortar. Excessive humidity can compromise the mortar's ability to adhere to the surface and can lead to the appearance of efflorescence, stains, and detachment, which is the focus of the work. (MADEIRA, 2019).

Figure 1

Representation of peeling in ceramic tiles



Source: QUARTZOLIT (2018).

Figure 2

Peeling off in ceramic coating



Source: RESMASTER ENGENHARIA (2018).

2.7.1 Types of mortar

According to MADEIRA (2019), there are three types of adhesive mortars that are the most used in works for the laying of ceramic tiles. The first of these is ACI, used specifically to fix floors and natural stones in internal areas, such as floors and walls. The "AC" refers to the acronym "Adhesive Mortar", and the number "1" indicates the performance rating of the product. Adhesive mortars are designed to provide a strong and long-lasting direction between the coating and the application surface. The ACI rating generally refers to a mortar that performs well for indoor areas, with little exposure to moisture, and no specific deformation requirements.

When using ACI adhesive mortar, it is important to follow the manufacturer's instructions for mixing ratio, application time, surface preparation, and other specific requirements. Each manufacturer may have different formulations and recommendations for their products, so it is essential to read and follow the guidance provided.

The ACII adhesive mortar is a type of adhesive mortar with a higher performance rating compared to the ACI. It is designed for indoor and outdoor applications with increased exposure to moisture, such as bathrooms, kitchens, and laundry areas.

The ACII rating indicates that this mortar has a higher capacity for deformation and adhesion compared to ACI. It is more suitable for situations in which there may be greater movement of the experiments, such as thermal expansion, vibration or differential settlement. When using ACII sticky grout, it is important to follow the manufacturer's instructions for the best results. This includes correctly preparing the surface, applying the mortar according to the recommended proportions, and keeping track of the indicated curing and drying times.

Be sure to read and follow the specific instructions provided by the manufacturer of your chosen ACII adhesive mortar.

Finally, ACIII sticky mortar is another type of sticky mortar with an even higher performance rating compared to ACII. It is designed for indoor and outdoor applications with high exposure to moisture, movement, and deformation, such as swimming pools, facades, and floors with radiant heating. The ACIII rating indicates that this mortar has a higher capacity for deformation and adhesion compared to ACII. It is specially formulated to withstand more intense loads and movements, maintaining a secure and lasting fixation of the coatings (GIULIANO, 2015).

As with the other classifications, it is essential to follow the manufacturer's instructions for the best results when using ACIII adhesive mortar. This includes preparing the interface, mixing the mortar as per the recommended instructions, applying it correctly, and following the curing and drying times indicated by the manufacturer. Each manufacturer may have specific formulations and recommendations for their products, so it is important to read and follow the guidance provided by your chosen manufacturer.

2.7.2 Executive methods

For a proper laying of the ceramic tile, it is necessary to use appropriate tools, as well as a qualified workforce for the service. The tools needed for the service are: carpenter's pencil, hose level, plumb, trowel, spirit level, pointer, nylon line, aluminum ruler, tape measure, articulated meter, square, nail, brush, chisel, steel or nylon brushes and sledgehammer. Other materials that may have been essential are spacers, to maintain the thickness of the joints, and soft sponges to promote the cleanliness of the environments (REBELO, 2010).

To avoid peeling in ceramic tiles, it is important to follow the manufacturer's guidelines regarding the characteristics of the substrates and mortar to be used, as well as the instructions for laying and finishing the ceramic, as specified in NBR 13754 (ABNT, 1996). It is also important to ensure that the base where the ceramic will be laid is firm, level, and free of excessive moisture, always remembering the importance of a quality system in the execution of services on the construction site.

If it has already caused detachment in the ceramic tile, it is necessary to evaluate the cause and the degree of severity of the problem. Small areas of peeling can be corrected by applying adhesive mortar or grout, while large areas may require replacing damaged coating. In more severe cases, a technical diagnosis is necessary to verify whether the cause of the detachment is related to related or design problems (DOUGLAS et al., 2017).

3 METHODOLOGY

In the methodology, the focus will be exclusively on a case study, providing specific details for a deeper understanding and analysis of the data obtained.

3.1 CASE STUDY

The study presented addresses a real case of detachment of internal ceramic coatings in a construction located in Goiânia-GO, in Residencial Porto Dourado 01, in which the possible causes of the emergence of this pathology will be addressed, such as lack of qualified labor, inadequate preparation of the substrate, use of mortar in an erroneous way or even the use of mortar not suitable for the situation and material. As well as the possible solutions, based on the literature review made.

Thus, the objective of the case study is to understand and describe the phenomenon in question, analyzing its characteristics, processes, causal relationships and contexts. It allows for an in-depth analysis of the particular case, allowing the exploration of numerous variables and perspectives.

In summary, the case study is especially useful to analyze the situation in loco, obtaining a detailed and contextualized understanding of a phenomenon considered complex. However, by observing closely, it is possible to better see how the service was performed and thus understand, through studies and research, the causes and solutions to the observed problem.

4 RESULTS AND DISCUSSION

This segment will focus on the case study, presenting the location where it occurred, a detailed description of the affected building, and the analysis of the causes that led to the identified problem. In addition, images will be displayed that illustrate the pathology in question. Consequently, the solutions adopted to effectively resolve the situation in question will be explored and detailed.

4.1 AREA UNDER STUDY

The peeling of coatings is a common pathology in vertical constructions, involving the detachment of the applied coatings. This problem can arise due to problems in the application, improper use of materials, inferior quality of the mortar, structural movements, external action and weathering. In addition to compromising aesthetics, this detachment can lead to infiltrations, impairing the integrity of the structure and contributing to problems such as the emergence of fungi, corrosion of metal structures, among others. Preventing this

pathology requires qualified professionals, compatible materials, and the study of environmental conditions. In cases of occurrence, a detailed investigation of the causes is crucial, followed by corrective measures such as removal and reapplication of coatings and structural corrections, always with specialized support.

4.1.1 Location of the building

This work is a case study carried out in a residential building, located in the city of Goiânia and in the Andreia Sector, Block 02 Lot 01, in the Porto Dourado Residential 01, and in the following geographic coordinates: 16°47'44" S (latitude) and 49°21'42" W (longitude). In Figure 3, the image of the geographical location of the construction, acquired through Google Earth, clearly reveals the presence of other vertical buildings in the same area, pointing to a clear trend towards this type of construction in the region.

Figure 3

Representation of the location of Residencial Porto Dourado 01



Source: Prepared by the authors.

4.1.2 Description of the building

It is a multifamily residential building, which was built by Vila Brasil Engenharia. It consists of 46m² apartments with two bedrooms, bathroom, living room, kitchen, service area and garage. Condominium with gym station, adult pool and children's pool, fitness area, shower, sauna, playroom, party room, square, barbecue grills, playground and grassy field.

4.1.3 Description of Observed Pathological Manifestations

The presence of issues in ceramic tile has a vital connection with the quality of the installation, playing a crucial role in its durability. As the investigation deepens, the impact of sound installation techniques will be thoroughly examined, highlighting how consistent and

careful practices can prevent and solve potential problems. In addition, the role of the materials used will be discussed, highlighting the importance of appropriate choices to ensure the integrity of the coating over time. Exploring these aspects not only broadens the understanding of the associated challenges, but also offers valuable insights to improve future facilities, promoting more resilient and high-quality outcomes. In several housing units, small protrusions were identified on the ceramic plates in bathrooms, kitchens and laundry rooms, as shown in Figures 4 and 5.

Figure 4

Representation of protrusion in ceramic coating



Source: Prepared by the authors.

Figure 5

Ceramic coating protrusion



Source: Prepared by the authors.

In some regions, there was significant detachment of the ceramic tile, indicating a lack of adhesion between the tile and the mortar used to fix it, as illustrated in Figures 6 and 7. The back of the ceramic pieces showed a lack of connection with the adhesive mortar,

resulting in little or no adhesion. This highlights the importance of proper installation and attention to detail to avoid future problems.

Figure 6

Representation of the location of Residencial Porto Dourado 01



Source: Prepared by the authors.

Figure 7

Representation of the location of Residencial Porto Dourado 01



Source: Prepared by the authors.

4.1.4 Diagnosis of possible causes and origins of pathological manifestations

Coating peeling can happen for a variety of reasons, including planning issues that didn't account for possible movement in the substrate or used a low-quality base. In addition, leaks in the walls or floor that cause moisture are also a frequent cause of this problem.

Alteration of the substrate, whether due to factors such as thermal variations, vibrations, or improper settlement, can result in the peeling off of the coating. The lack of qualification of the workforce and the application of the coating without proper preparation of the substrate are also factors that contribute to this issue.

The excessive use of water in the fixing mortar, the use of expired mortar and the adoption of inappropriate practices, methods and tools weaken the adhesion between the coating and the substrate, resulting in peeling. In addition, the choice of inappropriate products for the application of the coating can compromise its adhesion.

Based on inspections and data collected during the investigation of ceramic detachment in a specific apartment, one of the first points of analysis was directed to the possible influence of structural movement as an underlying cause of this phenomenon.

However, despite the proximity of neighboring buildings, no cracks or any signs of movement that could affect the ceramic pieces inside the apartment under study were identified. This absence of relevant structural changes in the nearby constructions led to the exclusion of structural movement as a determining factor for the observed detachment.

This finding not only dismisses one of the possible initial causes of detachment, but also highlights the structural stability of adjacent buildings, contributing to direct the investigation to other possible reasons underlying the phenomenon of ceramic delamination.

The next step of this study focuses on the detailed analysis of other hypotheses, seeking to accurately identify the underlying cause of the detachment of the ceramic pieces inside the apartment under study.

In addition to the analysis performed to rule out structural movement as the cause of ceramic detachment, another possible hypothesis considered was infiltration. Given the potentially destructive nature of the water infiltrated in the construction materials, the presence of infiltration in the apartment under study was investigated.

Contrary to initial expectations, the inspections did not reveal any traces or evidence of infiltration in the areas affected by ceramic peeling. The absence of traces of moisture, stains or damage characteristic of infiltration contributed to the discarding of this hypothesis as the cause of the observed detachment.

As in the case of structural movement, the exclusion of infiltration as an underlying cause of the detachment reinforces the need to explore other potential causes that may explain the phenomenon that occurred inside the apartment under study.

In addition, a third hypothesis considered was the displacement due to the joints between the ceramic pieces. After some evaluations, no evidence of excessive wear, adhesion failures or other problems in the joints between the ceramic tiles affected by the

peeling was identified. This finding led to the exclusion of displacement due to joints as an underlying cause of the observed phenomenon.

Thus, the absence of evidence of wear or failures in these junctions reinforces the conclusion that they are not responsible for the detachment of ceramic pieces, directing the investigation to other possible causes for this specific phenomenon.

After an analysis of the remaining hypotheses, a more concrete conclusion emerges about the cause of the ceramic detachment observed in the apartment under study. Among the possible reasons investigated, the misapplication of the laying mortar emerges as the main cause for the observed phenomenon.

Details provided by the engineer in charge corroborate the hypothesis that the inadequate technique in the application of the mortar may have played a crucial role in the detachment of the ceramic pieces. This finding is reinforced by the lack of in-depth research on the quality of the material used, suggesting that poor application may have been a determinant for the problem faced.

Considering the relevance of this finding, the understanding of the misapplication of mortar as the main cause of ceramic peeling not only clarifies the observed phenomenon, but also highlights the critical importance of the proper execution of laying processes in construction projects.

The observation during the inspection of the work revealed an inadequate application of the adhesive mortar, evidenced by its fragmented and uneven distribution on the ceramic pieces. Different points of the pieces were partially covered, leaving empty spaces and areas with little adhesion to the substrate. In some places, the application was practically non-existent, resulting in inadequate or no adhesion.

This irregular and deficient execution resulted in an unsatisfactory adhesion of the mortar, which, as a direct consequence, led to the detachment of the ceramic pieces. The inconsistent and poorly executed application of the laying mortar emerged as the preponderant factor for the observed detachment, demonstrating the critical importance of adequate procedures in the installation phase for the durability and stability of ceramic structures.

4.1.5 Discussion

The detachments identified in the apartments arose as a result of an inadequate application of the adhesive mortar. In this process, the mortar was applied in small quantities, resulting in poor adhesion between the mortar and the coating. This deficiency in adhesion caused the detachment of the coating in several units of the condominium. This phenomenon

deserves further analysis, as it has an impact not only on the aesthetics but also on the structural integrity of the housing units in question.

The coatings of the apartments underwent a replacement process due to the detachment that occurred previously. To solve this problem, it was necessary to perform a complete leveling of the base. In addition, the application of the mortar was conducted according to the appropriate techniques, ensuring effective adhesion between the mortar and the new coating. This intervention not only restored the aesthetics of the environments, but also ensured the structural integrity of the housing units, providing a safe and visually pleasing environment for residents.

5 CONCLUSIONS

The work consisted of compiling information about the elements of the ceramic tile, describing the application process and characterizing the pathologies that may arise, identifying their origins. The objective was to connect this knowledge to facilitate the understanding of the origin of failures in ceramic tiles, including specific insights obtained through the case study on delamination.

The research developed provided several conclusions about ceramic tiles and the issues related to their failures. It was possible to thoroughly examine the individual characteristics of the materials that make up this system, from the ceramic block and its properties to the mortar layers and their respective roles in the coating. In addition, we have covered ceramic plates, highlighting their proper handling and storage ways.

Identifying these elements in isolation facilitated the understanding of the system as a whole, enabling an integrated analysis of the characteristics and how they are related to the emergence of problems. We also describe the proper procedure for attaching the ceramic slabs, from the production of the mortar to the selection of the appropriate tools and the laying process, including quality checks throughout the work.

Additionally, it is important to mention that a specific case study was conducted on the delamination of ceramic tiles. This study provided an understanding of the possible causes and factors involved in this specific problem, contributing to a deeper knowledge of failures within the context of ceramic tiles.

In addition, the most common pathologies observed in ceramic tiles were detailed, with emphasis on ceramic peeling, illustrating the problem with images. Based on the knowledge acquired about the elements and processes involved, possible causes for these failures were identified.

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