



Analysis of pathologies caused by humidity in civil construction

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Abstract

In search of better comfort and productivity, man has sought information, since antiquity, about civil construction, because, as society has become more complex, knowledge about construction has become an essential skill for human beings. In this context, the present work aims to present a simplified theoretical review on pathologies caused by humidity, and added to these characteristics, to approach ways for possible solutions, seeking to remedy the different problems caused. The present study was written through a bibliographic review on the different problems caused by pathologies caused by humidity, with a focus on solutions. For this, research was carried out on the subject, through a survey of theoretical sources (journals, scientific articles, books, theses, among others) and a theoretical framework that underlies the history of civil construction and the different characteristics acquired over the years. time. Humidity is a pathology that causes some problems in construction and mainly impacts the financial management of the project, as the final value of the work can undergo major changes until the final solution of the problem. Humidity is capable of causing fissures and cracks, compromising part of the construction structure, in addition to other problems that affect aesthetics, such as mold, efflorescence, mildew, blisters in the paint, loss of plaster and rust. As the main causes identified for the appearance of this pathology, we can mention the lack of prevention, since the lack of waterproofing products compromises the quality of the work, causing infiltrations. The lack of ventilation and high humidity in the environment must also be observed, as they generate moisture by condensation resulting in problems such as stains and mold on ceilings and walls. The hydraulic installation

is also considered, since it is important that this system has the correct and necessary sealing to avoid contact of water with the structure.

Key words: Pathology, moisture; waterproofing; durability.

1. Introduction

In search of better comfort and productivity, man has sought information, since antiquity, about civil construction, because, as society has become more complex, knowledge about construction has become an essential skill for human beings. , which according to [1], sought to adapt the structures, which should adapt to their needs, regardless of the purpose, whether housing, work activities or infrastructure, allowing over time, an in-depth analysis of the construction technology and all its complementary aspects, ranging from the conception of the work to the construction techniques.

Over time, the need arose to deal with various anomalies arising from the degradation of materials and elements that contribute to the system of a building. According to [2], construction pathology should always be seen as an unwanted, but certainly inevitable, step towards quality. In practice, the pathology of constructions concerns the study of situations of occurrence of problems, failures or defects that compromise one or more of the functions of the building, or its entire set.

The pathologies, for the most part, arise from poorly designed projects and poorly executed constructions, common mistakes allied to poor workmanship, thus making it necessary to restore the damaged structure [3]. Certainly, one of the most constant problems in construction is water infiltration, favoring initial problems such as stains, bubbles, mold and cracks. Therefore, to avoid such a problem, [4] says that the waterproofing process needs to be carried out in the place that requires watertightness, thus promoting the reduction of such pathology.

In this context, the present work aims to present a simplified theoretical review on pathologies caused by humidity, and added to these characteristics, to approach ways for possible solutions, seeking to remedy the different problems caused.

2. Materials and Methods

The present study was written through a bibliographic review on the different problems caused by pathologies caused by humidity, with a focus on solutions. For this, research was carried out on the subject, through a survey of theoretical sources (journals, scientific articles, books, theses, among others) and a theoretical framework that underlies the history of civil construction and the different characteristics acquired over the years.

The literature review demonstrates the updating of the latest discussions in the field of research knowledge. In addition, it is highlighted that the purpose of scientific research is focused on the development of the interpretive nature of the data obtained [5].

Thus, it is essential to correlate the research with the theoretical universe, based on a model that functions as a basis for interpreting the meaning of the data.

3. Theoretical Reference

3.1 The concept of pathology

With the advancement of technical-scientific knowledge, in relation to the design and construction process of the most varied buildings, certain problems also emerged, such as pathologies, deteriorations that occur in a given work and can have their origin in all phases of construction, whether in services preliminary, in the execution, in the finishing or in the occupation phase.

Thus, [1] indicate that the causes of deterioration can be the most diverse, going through the "natural" aging of the structure, and even the irresponsibility of some professionals who choose to use materials outside the specifications, explained by economic reasons. In this way, the number of factors can promote great concerns, since even having problems with the act of building, arising from the first constructions, where such issues did not present a systematic character, considering only occasional problems.

The same author mentions that deterioration occurs due to several characteristics, such as errors in projects and in the execution itself, which can lead to an accident or even, the question of time itself, over the years, which can influence the durability of the materials used in each period. development, also highlighting the importance of using adequate, resistant and specific materials for each type of construction.

It is the responsibility of civil construction professionals to carry out a premature and accurate diagnosis regarding the manifestation of anomalies that may compromise a structure. Therefore, it is of great importance that there is quality control and regulation to minimize greater risks caused by the search for cost reductions in civil construction [6].

The concept of pathology in civil construction, described by [7] is described as a study of failures that alter the planned or existing balance, its nature and the damage caused by these diseases in buildings. [1] also present a branch of engineering, the pathology of structures, which is specifically dedicated to understanding pathologies and ways to prevent them preventively or in the search for solutions in case the problem already exists. In addition, structural pathology studies the base, which ranges from the origins, their forms of manifestation, failures and degradation of structures.

It is essential that civil engineering professionals have training capable of making them qualified in relation to the study of pathologies and their consequences. From this perspective, they will be able to have broad success in terms of avoiding or reducing these pathologies as much as possible and thus reducing the number of accidents, illnesses and expenses, among others.

3.2 The source of moisture in buildings

Humidity has always been present in civil construction, often allied in the production of concrete, and can be observed several times as the most constant cause in the appearance of pathologies. To understand the origin and action of moisture in buildings, it is essential to consider the action of climatic and weathering agents (temperature, humidity, rain) that act directly in civil construction in internal and external environments [7].

It should be noted that humidity does not only cause pathologies in buildings, but it is the essential element for the loss of plasters, paints, causes structural accidents, and allows the appearance of mold, mildew, efflorescence, and rust. There are several types of moisture that affect and degrade the useful life of the

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building: a. Rising or ascending dampness; b. infiltration moisture; c. condensation moisture; d. building damp; and. accidental moisture [8].

a. Ascending or rising damp

It occurs when there is infiltration by capillarity, through porous materials when they are submitted to contact with water or humid soil [9]. In other words, it indicates the absorption of water from the soil through the foundations and foundations, reaching floors and walls. For this reason, it is essential to waterproof these places to prevent this pathological manifestation [9] or even, the installation of a drainage network prior to the start of construction.

b. Infiltration humidity

Infiltration humidity comes from rainwater that penetrates buildings through the constituent elements of their outer envelope, associated with two climatic factors: rain and wind [6]. That is, without the wind, rain would fall vertically and would not wet the walls of a building, so there would be little or no difference in pressure between the inside and outside of the building. Infiltrations can also happen due to poorly done hydraulic installation on site, causing leaks and damage to the structure in regions close to the leak. So that this type of problem can be avoided, it is necessary to have a well-made hydraulic installation of the building, with correct sealing, preventing the contact of water with the structure.

c. Condensation moisture

This type of humidity occurs in more closed environments, with less ventilation potential and high humidity, such as bathrooms, saunas, kitchens and garages [10]. In addition, moisture by condensation can occur in two ways: superficial condensation and interstitial condensation, the first being more visible, occurring on cold surfaces, initially in places where thermal insulation is actually lower, corresponding to the case of heterogeneous walls, considering the structural elements. The second occurs within the layers of an element, from the inside of the building to the outside, being more difficult to identify because it is not visible [11]. The main pathological manifestations related to condensation are the appearance of mold, mildew and stains on ceilings and walls.

d. Building moisture

This humidity can be acquired by the building still under construction through the water that is used for its realization, being considered the least harmful of all, since it disappears over time without requiring any remediation [8].

e. Accidental wetness

Accidental moisture occurs in piping systems, such as rainwater, sewage and drinking water, which generate infiltrations. The existence of this type of humidity is of special when it comes to buildings that already have importance a long time of existence, as there may be the presence of materials with an already exceeded lifespan, which are not usually contemplated in building maintenance plans [12]. Its causes can originate from design and execution failures, as well as the functioning of installations and clogging [10].

3.3 Tipos de danos causados pela manifestação da umidade em edificações

Segundo [1], os danos que podem ocorrer pela manifestação da umidade em edificações comprometem a integridade tanto observando as características estéticas como a estrutural, e há uma dificuldade em identificar o causador de tais patologias, pois as causas são tantas que torna difícil definir o principal fator. Sendo assim, tem-se definido algumas patologias causadas por infiltração:

3.3.1 Porosity in paint – Bubbles

According to [13], all Portland cement-based surfaces are porous, therefore, this material absorbs an excessive amount of moisture. Therefore, this can bring numerous problems and advantages for the paint coating. The author also indicates that porous surfaces provide more base to the paint film, allowing better mechanical adhesion than smooth and hard surfaces, however these surfaces are easily contaminated when any liquid enters their pores.

[14] states that even if the manifestations of bubbles in the dye appear after the execution of the service, this pathology is due to a negligence that occurred at the time of the work.

3.3.2 Corrosion and cracking of concrete due to moisture

According to [1], the corrosion process of the environment where it is located, including the concentration of salts, acids and bases in its composition, can classify concrete corrosion into three types:

- a. The. Corrosion by leaching - consists of the dissolution of calcium hydroxide existing in the hardened Portland cement mass (released during hydration) due to the attack of water with few impurities, which will be responsible for corrosion if it is free to circulate and renew itself [15].
- b. Chemical corrosion – occurs through a reaction of existing substances in hardened cement, this happens when soluble compounds encounter moving or static water in the place where it was designed.
- c. Expansion corrosion - occurs due to sulfate reacting to cement components, thus causing an increase in volume causing its expansion and degradation.

3.3.3 Efflorescence

According to [10] efflorescence's are whitish spots that appear on the paint, caused by the leaching of soluble salts through chemical reactions, this accumulation is transported by water that comes into contact with air, manifesting this phenomenon.

According to [13], if the cause of the problem is humidity, it must be eliminated, considering any cracks on the surface with a water-based acrylic sealant. If the cause is moisture or steam, scrub the area with a wire brush.

However, the way to avoid the occurrence of this phenomenon is with an adequate waterproofing system such as exhaust fans and fans, as well as the use of less permeable building materials [16].

3.3.4 mold and mildew

According to [16], the manifestation of mold and mildew has its origin caused by unicellular protozoa called fungi, these organisms are responsible for the degradation of sites affected by humidity and infiltration. This phenomenon is described by patches of dark colors on the surface of wood and masonry. According to [15], the ideal environment for the proliferation of fungi and lichens is an exorbitant level of water in part of a structure, forming colonies of fungi that feed on biological material, leading to the degradation of objects and structures.

According to [16], the prevention of this pathology requires strong control of the lubricity of the site, eliminating possible infiltrations, ensuring good air intake and sunlight, and when the focus of the problem is identified, it is recommended to wash the site with cleaning products to prevent the reproduction of molds and mildews.

3.4 Waterproofing for the prevention of pathologies related to humidity

Moisture penetrates buildings in several ways, so its prevention is necessary at all stages of construction, thus becoming a crucial step to prevent these fluids from damaging the work in the future. According to [17], the waterproofing stage is one of the most significant phases of construction, but it has been postponed, most of the time to reduce costs and inaccurate information about the pathologies caused by humidity.

ABNT NBR [18] presents content that deals with matters about waterproofing, assisting in the methods of execution, so that the minimum requirements of protection of the construction against salubrities are met, as well as aiming at the safety and comfort of the user.

According to [19], waterproofing materials must be used according to the constructive actions imposed by the fluids, being separated into groups, Rigid and Flexible:

- a. Flexible Waterproofing: They are indicated to be used in places with greater movement and temperature variations, such as slabs. They are composed of blankets, or asphaltic membrane, acrylic membrane, modified polymer membrane [20].
- b. Rigid Waterproofing: They are indicated to be used in places that do not move or that do not suffer deformations, that do not have much sun exposure, thermal variations, such as foundations, retaining walls, buried reservoir, etc. Its composition is based on cement mortar, sand and waterproofing additives [21].

For the greatest success in waterproofing, the material must be in accordance with the application site. Some examples of waterproofing materials are: a. waterproof concrete and b. asphalt blanket, in addition to other examples such as polymeric mortar, liquid blanket, and others.

Waterproof concrete

Concrete is known to be a material with a large amount of pores in its structure, where water is the main reason for the amount of space, so that concrete can acquire characteristics that make it impossible for water to pass through, changes must be made. made. The change in the material is characterized by the addition of a waterproofing additive to the mix and the decrease in the amount of water used, delaying the curing of the

concrete. It is recommended to use the material in the plastering phases of the sealing, refractory and block masonry structure. After the procedure, it is feasible for the concrete to be humidified during curing, to reduce its porosity as much as possible [17].

a. Asphalt Blanket

A type of waterproofing, preformed, flexible or rigid. Each species of this waterproofing product has an efficient method of application and requirements to be followed, for its application the surface to be treated needs to be properly clean and free of sharp or irregular regions [22]. Its structure is made of an asphaltic base with polymeric additives and a blanket with the function of fixing the base and separating it from the external environment, and its application is carried out by pressure, followed by fixation with heat, with the help of the use of a torch, where the base momentarily loses part of its rigidity adjusting the waterproofing to the place to be protected. The asphalt blanket with the greatest workability is the aluminized self-adhesive [23].

Furthermore, we must consider at what stage of construction the waterproofing process is carried out, as:

Foundation waterproofing

Because moisture rises from the ground to masonry by capillarity, it is necessary to waterproof masonry foundations, where polymeric cements or waterproofing additives for mortar are used [20]. According to [14], baldrame foundations and other structures must carry out the waterproofing process to form a watertight layer against capillarity.

Slab waterproofing

Flexible materials must be used in this type of location, as already explained. In slabs with large dimensions, it is advisable to use an asphalt blanket, for smaller spaces, [14] guides the use of flexible membranes applying them in loco due to the ease of execution and not having amendments. After carrying out the waterproofing process, the tightness test is necessary.

Thus, knowing the importance of a good structure of a construction independent of the model, it is necessary to treat the waterproofing process as a primordial characteristic, for the long life of the structure, as well as the maintenance itself, reducing the problems that can be generated by the inverse process. In this context, a summary table will be shown on the causes and solutions of pathologies related to humidity (Table 1).

Table 1. Summary table on causes and consequences of pathologies related to humidity.

PATHOLOGY	CAUSE	CONSEQUENCE	SOLUTION
Mold/Mildew	Fluid leaks in the hydraulic network; design or execution failures.	Dark and greenish stains on the masonry, as well as precariousness of the surface.	Adequate ventilation; humidity control; monitoring of infiltrations in the hydraulic network.

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Bubbles	Incorrect application of paint; infiltration in the masonry; plaster drying time.	Paint peeling; conservation of masonry; aesthetic nuisance.	Choice of quality dye: Moisture and infiltration control.
Corrosion/cracking	Chemical agents, hygroscopy of materials such as mortar and concrete.	Cracks, expansion and fissures, in the axis of walls and unprotected places.	Adequate waterproofing system avoiding the contact of moisture with building materials.
Efflorescence	Chemical phenomenon due to surfaces exposed to salinization and humidity.	Appearance changes to a whitish color, which may signal later moisture problems.	Wash the area with running water and a brush with steel wires, and you can also use chemical products. that do not harm the surface of the environment.

Source: adapted [16]; [17].

5. Conclusions

Humidity is a pathology that causes some problems in construction and mainly impacts the financial management of the project, as the final value of the work can undergo major changes until the final solution of the problem.

Humidity is capable of causing fissures and cracks, compromising part of the construction structure, in addition to other problems that affect aesthetics, such as mold, efflorescence, mildew, blisters in the paint, loss of plaster and rust.

As the main causes identified for the appearance of this pathology, we can mention the lack of prevention, since the lack of waterproofing products compromises the quality of the work, causing infiltrations.

The lack of ventilation and high humidity in the environment must also be observed, as they generate moisture through condensation, resulting in problems such as stains and mold on ceilings and walls. The hydraulic installation is also considered, as it is important that this system has the correct and necessary sealing to avoid contact of water with the structure.

Therefore, the erroneous idea of cost containment during the execution of the work by not investing in a good waterproofing process, can generate a much higher cost with the appearance of these pathologies, increasing construction time, purchasing more materials and more expenses. for correcting the problems. Waterproofing carried out at the right time and following the standards required by technical standards is a guarantee of protection and quality, avoiding surprises and unwanted expenses in civil construction.

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