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Boroscopy: A Technique to Identify the Cause of Pathological Manifestations in Sewage Pipes in Buildings

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Abstract-This article is based on a pathological manifestation in the obstruction of the downpipe pipe of the sewage network, with materials from construction debris arising from the time of the building's construction, with the objective of studying the use of a non-destructive method to of boroscopy, this sensory perception diagnostic technique that uses a flexible probe with a mini boroscopy camera with the aid of a computer to visualize the interior of the pipe, having an immediate solution to correct and remedy the irregularities pointed out, thus avoiding the evolution of problems already existing and worsening of the situation, due to the facts that caused material and psychological damage due to these pathological manifestations.

Keywords- *Boroscopy, Pathological Manifestation, Sewage Network.*

I. INTRODUCTION

Currently, extending the useful life of buildings is something recurrent and necessary, both from a historical point of view, as it reflects the cultural richness of a society, giving it personality and acting as a "living document" [1] and to meet requirements related to economic viability and sustainability. In the general context, buildings are subject to a series of degradation agents such as humidity, temperature variations, exposure to aggressive chemical agents such as pollution and biodegradation. In addition to these factors, pathologies can also be caused by human failures in different stages of construction, not counting natural disasters [2]. In this context, it is necessary to develop forms of diagnosis that allow us to assess the type and level of deterioration of construction elements and analyze their life cycle, identify the causes of anomalies and proceed in order to prevent their evolution [3].

To ensure a good state of conservation of structures, it is necessary to constantly monitor their behavior and to accurately diagnose their state of conservation in order to avoid structural damage and ensure the reversibility of any intervention [4]. The diagnosis of pathologies as well as the control of the evolution of damage related to constructive aspects (electrical, hydraulic, structural) [4] enables a more punctual and economical decision-making, bypassing unnecessary inconvenience and leading to a gain in time, efficiency and savings in the process.

The non-intrusive diagnostic methods, in addition to being efficient, enable the analysis of extremely complex systems, such as the case of a hydraulic network that is the object of study in this article. Boroscopy is a diagnostic technique that meets the need to assess the internal structures of buildings in a non-destructive way, making its characterization in-situ both from a structural and constructive point of view [3].

To diagnose a structure we can use destructive, slightly destructive or non-destructive techniques. The analyzes go through sensorial, mechanical, thermal, chemical, electrochemical, electrical, magnetic, ultrasonic, radioactive, among others, techniques. In addition to the mentioned classifications, we can classify inspection techniques as sensory, through mechanical action, elastic waves, electromagnetic radiation, chemical reactions, electrical effects, detection and analysis of vibrations and hydrodynamics. The most used are the visual and instrumented inspection techniques [5].

In sensory perception diagnostic techniques, the professional uses the senses to diagnose the analyzed system. It embraces non-destructive techniques such as boroscopy that amplifies the system's visual analysis capability. Mechanical action techniques can be non-destructive, such as sclerometric testing, mildly or moderately destructive, such as extracting concrete samples to determine its strength. The elastic wave propagation technique enables vibration analysis and diagnosis of construction elements, being a non-destructive method of structural analysis. The techniques of chemical and electrochemical reactions refer to non-destructive and partially destructive tests, such as the assessment of carbonation depth, of analyzing structures. Thermographic testing is a non-destructive technique for analyzing the propagation of electromagnetic radiation. Dynamic techniques such as the Figg method correspond to a semi-destructive test, carried out in loco [3].

The main objective of this work is to analyze how the use of boroscopy, as a diagnostic technique for sensory perception, contributed to the evaluation of a pathology in the hydraulic

network in a recently constructed building, in order to assess the cause of the problem and propose the necessary procedures for its correction without damaging the system, thus exemplifying its application.

II. MATERIALS AND METHODS

Considering the proposed objectives, an experimental and comparative method was adopted. Non-destructive testing was performed using endoscopic investigation with a mini-boroscopy camera.

A. Materials

The instruments used in the test were:

a) flexible metallic probe type plunger;

b) flexible probe with mini boroscopy camera;

c) notebook for data recording;

d) camera for external recording.

In Fig. 1, you can see some of the equipment used.

Figure 1. Preparation of equipment for endoscopic evaluation: a) Flexible probe being prepared, b) flexible probe with boroscopy camera, c) probe connected to the computer.

B. Methods

It consists of the technical inspection through boroscopy, being considered a partially destructive test, that is, causing the least possible damage [6].

Depending on the technical procedures recommended for surveys and inspections of this kind, the following steps were adopted:

a) Survey of the region, which sought to assess the physical characteristics of the land and surroundings, including topography, quality of supply networks, economic aspects of its users and quality of community facilities.

b) Determination of the property-reason, where physical characteristics involving age, construction pattern, state of conservation and survey of complementary projects were identified;

c) Thorough inspection and inspection of the area of interest in order to establish the best way to carry out the survey and make the diagnosis;

d) Endoscopic investigation with a mini-boroscopy camera;

e) Execution of filming and general and detail photography;

f) Preparation of photographic frames, with captions and markings;

g) Coordination of all technical data obtained.

In Fig. 2 it is possible to visualize the flowchart of the applied methodology.

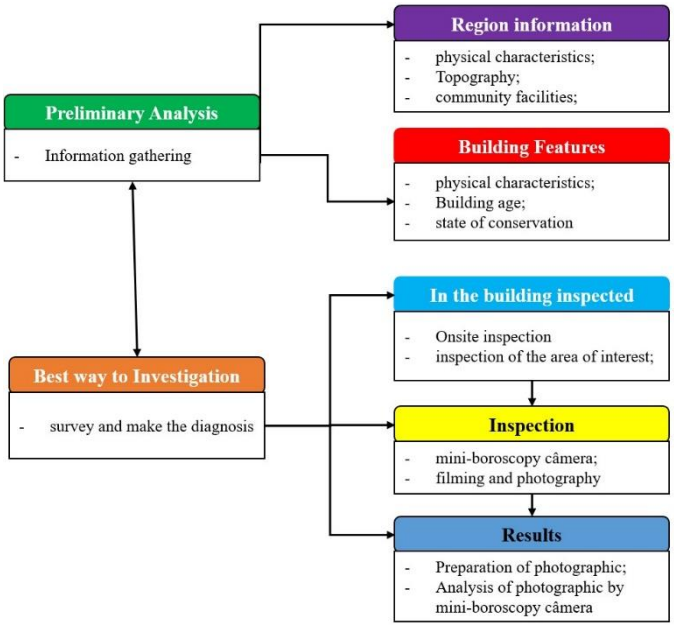

Figure 2. Flowchart of methodology

The property under analysis consists of a residential apartment, located in Minas Gerais, Brazil, located on a land of regular shape, slightly uneven, built 4 years ago. The finishing standard is low according to the parameters established by the PP-B of the New BUC/m² Standard Projects List - Sinduscon-MG [7].

In order to identify the cause of a backflow of sanitary sewage in the bathroom drains and under the toilet whenever the discharge from the upper floors (3rd and 4th floors) is triggered, the resident of an apartment on the 2nd floor

requested that diagnose the problem using a non-destructive method. Before the start of the work, an interview was carried out with the resident who reported having carried out a renovation of the bathroom, where finishing materials were changed. The hired professionals informed that the piping was clogged and at the time they provided a partial clearance, suggesting that a specialized company be subsequently hired. During the unclogging work, construction materials (plaster, Styrofoam and mortar) were removed from the piping, but it was not possible to completely introduce the probe because they encountered resistance in the piping that prevented the completion of the work. As a result, the sanitary sewage water leaked and soaked the entire apartment.

To enable the test procedure with the borescope camera, residents of the upper floors were asked not to use the sanitary installations for a period of at most two hours, including the breakfast break between 9:00 am - 9:00 am) and lunch (11:00 - 12:00 am hours), to avoid disruption to the neighbors' routine.

In Boroscopy, a flexible probe with a B-MAX boroscopy minicamera was used. This type of test is widely used in places of difficult access, with small thicknesses, historic buildings, and where it is not possible to visualize [1;8-10]. As interior of piping, internal part of structures (pillars, beams, slabs). The borescope consists of a flexible tube, with a light source and an eyepiece. It shows images of the analyzed elements and thus provides qualitative information [11].

Before starting the inspection, based on the photographs provided by the property owner and the projects that are in the possession of the condominium's accounting office, the project of the building's sanitary installations was analyzed. The objective was to understand how the project was prepared and to outline strategies for conducting the work.

III. RESULTS AND ANALYSYS

In the on-site inspection, initiated by the removal of the drains, the incidence of sanitary sewage in the water closure of the drain siphon box can be verified, a fact that should not occur, which generates great discomfort such as a bad smell in the sanitary environment [12], as shown in Fig. 3.

Figure 3. a) Siphoned drain with presence of waste water, b) Attempt to inspect the siphoned box drain

Due to the siphon in the box, it was not possible to introduce the equipment from that point on. Therefore, the removal of the toilet was provided to access the primary piping, also verifying the existence of residual water under the toilet bowl from some recent sewage reflux, which should not occur in accordance with [13], as shown in Fig. 4.

Figure 4. Removal of the toilet bowl and evidence of effluent backflow

When introducing the probe with the camera, it was observed that the section between the toilet and the TQ-2 Ø drop tube (primary branch) was completely full (full section) as seen in Fig. 5, something that should not happen, as the normal would be only part of the pipe section should remain with liquids. Therefore, the introduction of the camera was done with care to avoid the suspension of particles preventing the filming.

When entering with the camera in the sub-collector of the primary branch, it was possible to identify the connection of the branch with the drop tube, as seen also by the length of the probe already introduced in the pipe, and when making the curve with the equipment, you can see an orange colored object embedded in a hard material with whitish debris.

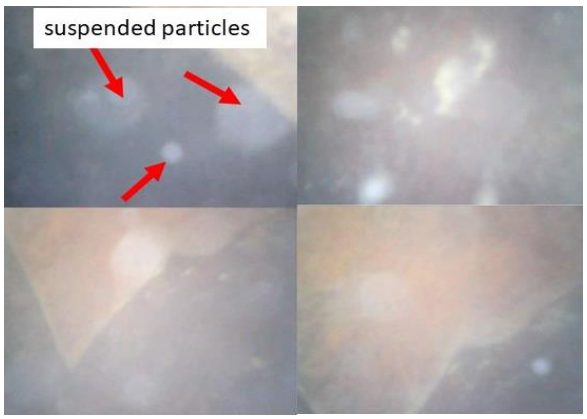

Figure 5. There is hard orange colored material with whitish debris. Primary branch with full section of effluent.

IV. CONCLUSION

Building sewage pipes are subject to obstructions, the consequences of which compromise the health, comfort and well-being of the people who inhabit the building. In view of the photographic evidence, footage obtained in the endoscopic inspection, and on-site verification, we can say that the problem presented in the property was caused by the obstruction of the downpipe pipe of the sewage network, with materials from construction debris resulting from the time of construction of the building, more specifically in Block 2, probably due to execution errors, as in other units of the condominium, this situation does not occur. Moisture from infiltration accelerates the process of deterioration of structures by inducing concrete degradation, corrosion of reinforcement, anomalies in paints and other coatings, thus compromising the durability of the building. The main function of a watertight and waterproof system is to provide the habitability and functionality of the building, as well as the health, safety and well-being of users, in addition to the preservation of real estate assets formed by the built heritage. Therefore, based on good construction practices in engineering and civil construction in current and applicable standards, in the terms transcribed from the Brazilian Civil Code and Consumer Defense Code [14], in view of the technical constructive non-conformities, and the lack of performance of the inspected systems, making it if necessary, immediate intervention is required to correct and remedy the identified irregularities, thus avoiding the evolution of existing problems and aggravation of the situation, due to the facts that caused material and psychological damage due to these pathological manifestations.

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REFERENCES

[1] MASCIOTTA, M. G, et al. "A multidisciplinary approach to assess the health state of heritage structures: The case study of the Church of Monastery of Jerónimos in Lisbon". Construction and Building Materials, vol. 116, p. 169–187, 2016.

[2] CORREIA, S.F.R. Catalog of diagnostic techniques in structural elements of common reinforced concrete buildings. Thesis (Master's degree) – Military Academy, Engineering Sciences and Technologies, Lisboa, 2014

[3] FERREIRA, J.A.A. Diagnostic techniques for pathologies in buildings. Thesis (Master's degree) Faculty of Engineering University of Porto, Porto, 2010.

[4] VARUM, H, et al. " Monitoring strategy for monuments: Case study – Arco – Cruzeiro of the Church of Santa Casa da Misericórdia of Aveiro ". Revista da Associação Portuguesa de Análise Experimental de Tensões. Vol. 17, Pg 65-73, 2009.

[5] BARBOSA, L. S. Inspection manual of old buildings in resistant masonry and wooden structures. TCC (Degree in Civil Engineering) – Federal Institute of Sergipe, Aracaju, 2021.

[6] BOSILJKOV, V, et al. "An integrated diagnostic approach for the assessment of historic masonry structures". Journal of Cultural Heritage, vol. 11, no. 3, p. 239–249, 2010.

[7] SINDUSCON, (2021). Basic Unit Cost - BUC. Retrieved from https://www.sinduscon-mg.org.br/cub/.

[8] FORDE, M. C. "Bridge research in Europe". Construction and Building Materials, vol. 2–3, no. 2–4, p. 85–91, 1998.

[9] GUILLEBERT, V, et al. "Development of a thermographic NDI system for service damage identification in inaccessible areas". Procedia CIRP, vol. 11, p. 124–129, 2013.

[10] PALLARÉS, F. J, et al. "Structural health monitoring (SHM) and Nondestructive testing (NDT) of slender masonry structures: A practical review". Construction and Building Materials, vol. 297, p. 123768, 2021.

[11] SANTOS-ASSUNÇAO, S, et al. "Assessment of complex masonry structures with GPR compared to other non-destructive testing studies". Remote Sensing, vol. 6, no. 9, p. 8220–8237, 2014.

[12] FERNANDES, V. S. "Impact of the use of microorganisms in siphon boxes in sanitary environments". Ambiente Construído, vol. 16, p. 121–131, 2016.

[13] BRAZILIAN ASSOCIATION OF TECHNICAL STANDARDS: ABNT NBR 8160: Building sewage systems - Design and execution, Rio de janeiro, 1999.

[14] CONSUMER DEFENSE CODE - BRAZIL, Law nº 8.078, of september 11, 1990, Edition 2020/2021.

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