

## Constructive Errors and Pathologies in Single-Family Homes: A Case Study in Manaus-AM

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### Abstract

*The process of buildings and constructions, in general, does not follow the normative profile, not because of the lack of norms, but for a traditional issue of making the buildings in an artisanal way, this causes a predisposition to errors and consequent problematization of the constructions. The task of regulating these inconsistencies arising from constructive errors is present in the discussion wheels on the quality of services that almost never follows a specified standard. But when these incompatibilities begin to cause harm to people and interfering in health, infrastructure, quality of life and, above all, in the economy since the development of certain pathologies in buildings, decisively affects numerous indicators in residence. For this study, the*

*consolidated information base was consulted in order to raise conditions for discussion about the impacts that are caused by the presence of anomalies resulting from construction errors. In this study, a survey of the conditions of construction and dimensioning of errors was made, for a case study on a single-family residence, with the identification of impact factors and the correlation of the guidelines within the proposal of adequacy and repair of anomalies.*

**Keywords:** Single-family residence. Constructive Errors. Pathologies.

## 1. INTRODUCTION

The construction of cities and their entire structure requires planning, a main aspect that is based on the ability to combine random and/or punctual mechanisms to generate solutions, innovations and personification of systems. Society is characterized by its living condition, and residence, clothes, speech, customs are factors that definitely define a society.

Building is not such a simple task, as the building process tends to incorporate a traditional mechanism, that is, many of the changes in standards are designed and carried out by curious laymen and do not meet normative criteria regarding safety, the combination of elements and others.

The artisanal way that is applied causes a predisposition to execution errors and consequent problematization in the constructions. The responsibility to promote corrective actions and application of standards lies in the regional councils that tend to subsidize conditions for poorly structured buildings to undergo adjustment and when they do not have the means to remedy, carry out their demolition.

Anomalies caused by poorly planned or biased insertions cause damage that can be felt immediately or can be delayed but will always cause certain discomfort and harm. Envision these degenerative practices that, without intervention, become normal practices that can be perpetuated within constructive processes.

In this study, which discusses the pathological manifestations caused by construction errors and other erroneous insertions in the process, a survey of the construction conditions and error dimensioning was carried out for this purpose, for a case study in a single-family residence, with the identification of impact factors and the correlation of the guidelines within a proposal for adapting and repairing anomalies, whose method associates the observation of a particular case that intends to assess the impacts of the implementation of errors that cause inconvenience to the user.

The expectation with the completion of this study is awareness for the application of legal means for the buildings, highlighting the risk factors that impact on poorly structured constructions and triggering the professional in the area to support the construction of the project, the indication of impact factors and thus, economically viable to apply the necessary guidelines to carry out the work.

Analyze the occurrences of construction errors in buildings built without the proper technical character, making a survey and discrimination of existing pathologies, constituting a case study in a single-family residence in Manaus. Identify the causes of the occurrence of construction errors in rustic buildings in the city of Manaus. Discuss and discriminate the constructive errors existing in the studied building, making a bibliographical approach on the existing pathologies. Propose a system for adapting the building with the adoption of technical elements to enhance the structure, as well as preventive maintenance and structural stability.

When showing signs of structural problems, caused by different situations, it is necessary to make a survey of the quality conditions of the building, the expert report is indicated because it can survey and detail parts that can evolve into a progressive breakdown of the building.

Almeida (2019) reports that regarding the total and relative housing deficit, the Brazilian capitals that present the highest housing deficit are: São Paulo (474 thousand), Rio de Janeiro (220 thousand), Brasília (126 thousand), Salvador (106 thousand) and Manaus (105,000 units).

This indication about the condition of housing deficit puts the city Manaus in the spotlight and the worst part of this is not in favor, as it is the capital with the worst relative deficit, with 22.9%, according to studies by FUNDAÇÃO JOÃO PINHEIRO [ FJP], 2013, p. 48).

The description of studies that highlight that Manaus is a city that has a large part of its buildings in irregular situations and prone to risks, studies show that the housing deficit in Brazil is composed in more than 70% of family cohabitation (43.1%) and excessive burden of rent (30.6%), in addition to precarious households (19.4%), and excessive density of rented households (6.9%).

Thus, the residence that is the target of this study fits in the situation of a house that suffers from damage caused, from the form of choice and compaction of the land, the application of the improvised construction system and little focused on meeting the standards, and even within an individual who needs mobility and access lives inside the residence, and the residence, in its present form, becomes a cage for him.

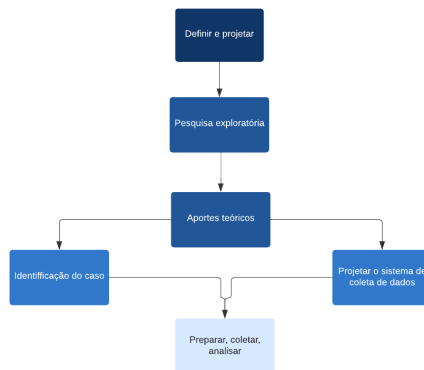
## 2. METHODOLOGY

It is an exploratory and field research with the observation of reality within an assisted residence for intervention, in this context a technical visit was carried out that identified the different anomalies that the building presents. The study is now based on the perception of norms and intervention needs in the structural part and adjacent details.

As this is a case study in a single-family home, a survey of the characteristics of errors, indication of pathologies and guidance for the construction of new demands was carried out, overlapping erroneous practices.

In this way, the study can be conducted as specified in Figure 1, which generically describes the application of a case study.

**Figure 1-** The case study and strategic planning



## 3. LITERATURE REVIEW - THEORETICAL FRAMEWORK

This section tends to raise the data that support the understanding of applications and understanding of pathologies, thus enabling discussion of possible interventions regarding the organization of the system.

### 3.1 Constructive errors and pathological manifestations.

For Almeida (2016), the study of the pathologies of concrete structures is relevant as it allows for the identification of existing errors, caused by the erroneous insertion of structures in the construction process. Thus, the main pathological manifestations existing in civil construction structures are identified by the inadequate alternative of elements of the implementation project, especially in the calculation system.

In the process of choosing the elements, when identifying the incompatibilities between the projects, since the construction was built without a description of a project that could discriminate the flaws in the specification of materials, which are detailed as problems arise, whose causes must be properly identified, demonstrating the lack of specifications in the drawings in the floor plan project and 3D simulation, this may allow for the possibility of adjustments to the structure that presents problems.

According to NBR 15575-2 (Brazilian Association of Technical Standards, 2013b, p. 3) the crack of a structural component is the "[...] capillary opening caused by normal or tangential stresses", cracks can be classified as active or passive, the active ones, also labeled as live, are those that occur with variation in the opening value due to thermal movements or other reasons, whereas the passive ones are those in which the opening remains constant over time.

The importance of planning to look for solutions regarding the occurrence of construction errors, for this the knowledge of anomalies can be collaborative so that preventive actions are taken to prevent the construction from being degraded in fundamental parts (ALMEIDA, 2016, p. 21 ).

About the cracks Acker (2014) apud Almeida (2016) mention that they are generally due to failures that could have been avoided if treated in a preventive way, as follows:

- a) proper dosage of concrete, optimizing the fines content, thus reducing porosity.
- b) choice of the size of the coarse aggregate compatible with the formwork and the covering, avoiding the risk of cracks due to segregation of fresh concrete and ensuring that the water retention of the mixture is not inferior to that stipulated in the project.
- c) concern with choosing an adequate healing process, preserving the risk of cracks due to plastic shrinkage. [...] (ALMEIDA, 2016, p. 21).

The material specifications for the system to gain consistency and impact on the quality of the erected structure, the optimization of the system involves the need to maintain the expectation of balance with the dosages, the quantification of inputs and also the size of the granules.

According to Correia (2017, p. 5)

“Despite the construction phase having a dominant influence on the performance of the final product, in Brazil there is a high incidence of failures that can generate numerous pathologies. Generally, these failures originate from design errors, in planning, in the specification of materials, among others, and some failures in the execution itself are also easily identified”.

The quality of a system is linked to the proposed planning that lists the demands to be worked on, according to Correia (2017, p.5):

"No project is absolutely perfect and design errors will always exist, but some of them manage to reduce to a minimum and reach the end of the work with a minimum number of problems, and, despite the difficulties, many projects finish successfully, following a good project and with intense supervision.

How can you understand the chance of having a problem in the project, since it is predisposed to occasional factors that collaborate for errors to occur, but the possibility of reducing the possibility of errors occurring brings confidence in the execution of the project that needs periodic self-correction, to follow the suitability trend?

The occurrence of errors feeds the incidence of pathologies ranging from simple systems to extreme situations, this differentiation of the possibilities of errors can be estimated in the design of the project that addresses the structures in a conscious way that there will be some chances that hinder the execution of a work.

### **3.2 Service life and durability**

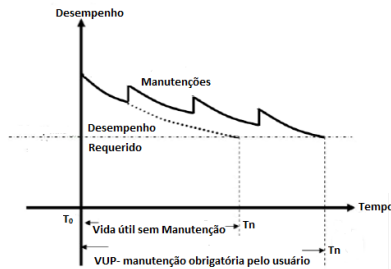
According to De Moura Silva (2019) the useful life is defined by ABNT NBR 15575-1:2013 and by ISO 15656-1:2011 as the period of time in which a building and/or its systems lend themselves to the activities for which were designed and built considering the periodicity and correct execution of maintenance processes.

The characteristics of the materials and the quality of the construction in its entirety, allow measuring the correct use and operation of the building and its parts, the maintenance actions, directly interfere in the useful life.

The relationship established when taking maintenance actions tends to prolong the performance of the useful life of buildings, since the standard of ABNT NBR 15575-1: 2013 highlights that the integral maintenance of the system is important to preserve the useful life system, otherwise it is compromised whatever the corrective action of preexisting pathologies.

Figure 2 highlights a system for monitoring the life of a building, observing performance in accordance with standards.

**Figure 2- Temporal monitoring of system performance**



**Source:** De Moura Silva (2019)

The durability and useful life of a building can be monitored and when any inconsistency is verified, maintenance must be carried out to preserve the structure, so the useful life of the building tends to be seen by the quality of the material and the conditions of physical characteristics of the system.

### **3.3 Mechanical resistance to system characterization**

ABNT NBR 15575-2:2013 describes the structural safety aspect and which the building must meet throughout the project's useful life, under the various exposure conditions (self-weight action, use overloads, wind and others) generally refer to not causing a feeling of insecurity to the user, nor does it affect the normal functioning of the installations in view of the deformations of structural elements (HENRIQUE, 2017. Page 10).

The planning of the architectural project, as well as the walls and all the structures, must meet the environmental requirements, the maintenance of the building over the years and the healthiness of the internal space.

Henrique (2019, p. 10) emphasizes that coatings must meet performance requirements relating to:

- Ability to absorb deformations - thermal, hygroscopic and differential movement between components.
- Adhesion to the base – ability to absorb deformations of the base;
- Impact and surface wear resistance;
- Low permeability or impermeability to water;
- Permeability to water vapor; it is worth highlighting the importance of choosing the coating to be used on the facade and the aspects that must be observed so that its functionality and performance contribute to the durability of the facades.

The conjunction of information that supports the execution of a project, taking precautions to mitigate error problems caused by lack of measurement of the physical properties of materials.

### **3.4 Influence of performance and support**

The factors that interfere in the final strength of the applied material, whose axial efforts to understand are all related to physical and mechanical properties, many studies have been carried out (THOMAZ, 2000; SABBATINI, 2007; Henrique, 2019) highlight that the procedure has to lead in considering the formalizations of the parts that make up the system and thus, the applications being made with the minimization of damage.

The presentation of incompatibilities between the imposed deformations and admissions within the sectors in order to avoid cracking, displacement, water penetration, connection in the masonry and the aggregation of aligned devices to observe the weak points and the maximum deformations of the elements being respected.

## **4 RESULTS AND DISCUSSION**

### **4.1 Characterization of a Single-Family Residence**

The construction of society from the perspective of quality of life involves its housing, houses, houses are, to a certain degree, the greatest asset of a family. It is in this core of experiences that triggers the awakening to other activities.

Norbert Elias (1994) in his book "The Society of Individuals mentions: "In this world, where power was distributed more evenly between human groups and multiple representatives of non-human nature, where the balance of power between human and non-human beings had not yet tipped, as later, towards the human groups endowed with facilities and housing built by themselves, the group had an indispensable and unmistakable protective function for the individual" (ELIAS, 1994. p. 115).

Bringing this excerpt from the author's writing, we seek to emphasize that the construction of a residence is a necessity, which reflects the dignity of being something aimed at protection and the impact of security. In ancient times, houses were built based on Human curiosity, which for some social strata, today, is still very much alive and reflects the realities experienced.

This alternative of construction based on the perception of need without technical support poses serious risks to the building's life.

The construction of single-family houses, especially in the outskirts of large cities, does not meet the technical criteria necessary to serve as a safe and comfortable environment for its residents.

Single-family houses refer to the place inhabited by a single family, preserving particular characteristics for each situation of inhabitants and that, throughout their life course, they will try to adapt the housing to its best way of taking advantage of space, mobility and comfort. These attempts at

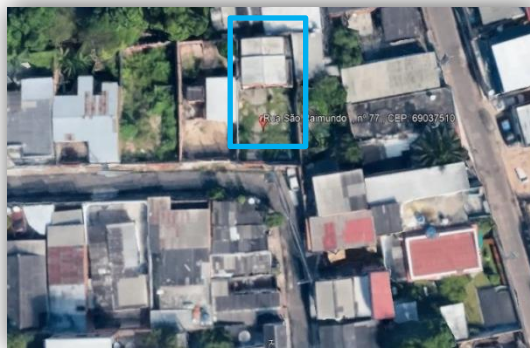


self-adjustment and proper adjustments can be very harmful to the building, since any given action can compromise important sectors of the building.

#### 4.2 The case of the target residence in the study

Due to the need to adapt to the mobility of a family member, the residence, located at Rua São Raimundo, nº 77, as highlighted in Figure 3, became the case under study. The opportunity to perceive a niche of many observations and applications is what motivated this study.

**Figure 3 – Residence location**



Source: Adapted from Google Maps (2021)

**Figure 4 - Facade of the single-family residence**



As can be seen, at first glance, in Figure 4 above, some critical points that draw attention to housing that accumulates a multitude of problems. The need to make it accessible between the lower and upper rooms is what draws the attention of the inspection team.

The residence has numerous occurrences of pathologies that demand the lack of preliminary studies that could have minimized the structure,

Figure 5 shows a summary of some observations that were made during visits to the residence.

The modification of the material insertion system must be an alternative for change, whether in the cost-benefit context, or in the environmental condition and care for bad weather.

**Figure 5** - Identification of pathologies in the structure of the residence



The identified pathologies were duly classified by the inspection team, as a basis for the composition of the project to adapt the residence. The images in b, d,e,g,kel that are indicated with arrows in Figure 5, point to some type of crack or insertions in the walls, this survey demonstrates, in addition to the crooked walls, the terrain architecture, as well as the different compositions of the environment. In figures a, c, f, h, i, j they are circled highlighting some type of infiltration or looting in the structure of the property.

The residence was built on uneven terrain and the construction did not follow a defined criterion, as soon as it is observed, masonry points, blending with wood, signs of changes that were carried out randomly and others.

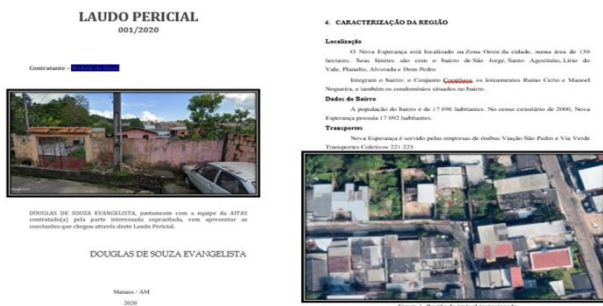
The occurrence of errors is undeniable that the residence requires urgent interventions, as its structure is compromised and as for the infiltration factor, there are clear signs that the entire lower structure receives a very significant dose of moisture and this factor favors the degradation of the structure, which What draws attention in figure 5 (h) is that the iron structures are exposed even in an area where they do not receive moisture, or for hours, they do not leave evident signs.

The work team managed to identify and label the different pathological manifestations in the residence and alerted the owners about the need for reformulation, where the owner replied that she was already aware of the situation and lacked a technical opinion to see how to acquire resources for improvement and adaptation of housing.

Given the proposal to study and assess the reality of the residence to collect data and introduce changes to the building, identifying errors and suggesting adjustments with the architectural design and budgeting. The observation of the points of greatest degrading activity brought to the work team the notion of the difficulties that are added when a project, or the absence of it, brings to the building.

As the owner intends to adapt her residence for the mobility of her child who has health problems, the existence of constructive errors was detailed, the taking of notes and the description of the conditions of pathologies in the building was the first point to be carried out. Then, the project team went on to discuss the best way to meet the resident's wishes with a project suited to her reality, whose pathologies show the regions of the residence where she has the greatest weaknesses, an indication that the changes must follow technical parameters and an expert REPORT was duly prepared that highlights and qualifies the needs and realities of the building.

**Figure 6-** Expert Report of the Single-Family Residence



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ao concreto convencional, pois resulta na adoção de espessuras menores, podendo não ser necessárias alterações significativas nas dimensões dos elementos reforçados.



Figura 4 – Sequência de fotos de construção de pilar – Incêndio Edifício Grande Avenida, São Paulo, 1981. Fonte: <http://zonadmerico.blogspot.com.br/2014/04/tembranca-incendio-do-edificio-grande-avenida.html>. Acesso em 25/11/2015.



Figura 5 – Esquema de reforço com utilização de concreto projetado. Fonte: modificação de HELENE, 1992 apud TAKEUTI, 1999.

9. ORÇAMENTO PARA REPARO ESTRUTURAL

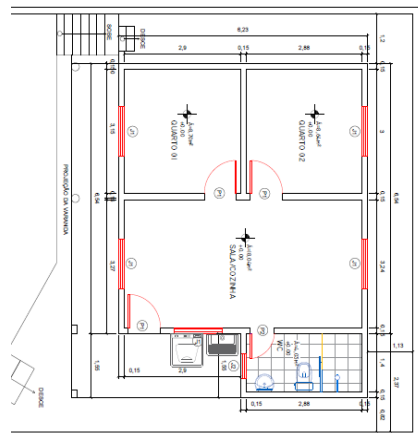
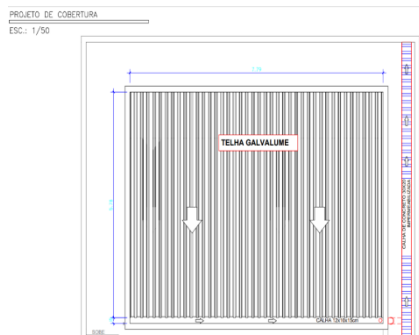
REPARO ESTRUTURAL DA LAJE				
ITEM	QUANTIDADE	UNID	VALOR UNITÁRIO	VALOR TOTAL
FERRA MANCA	1	DUZIA	R\$ 336,40	R\$ 336,40
TABUA	1	DUZIA	R\$ 300,00	R\$ 300,00
PREGO	2	hr	R\$ 12,00	R\$ 24,00
ESCOVA DE CERDA	1	Unid	R\$ 1,00	R\$ 1,00
PROTETOR DE ARMADURA	2	KG	R\$ 49,99	R\$ 99,98
BIANCO	1	Galão	R\$ 64,90	R\$ 64,90
LIXA	10	Unid	R\$ 0,50	R\$ 5,00
DESEMPENADERA	1	UNID	R\$ 18,00	R\$ 18,00
IMPERMEABILIZANTE QUARTZOLITE	1	LATAO	R\$ 300,00	R\$ 300,00
GRAUITE	5	KG	R\$ 60,00	R\$ 300,00
ARGAMASSA ESTRUTURAL	5	KG	R\$ 35,00	R\$ 175,00
PICARETA	1	Unid	R\$ 52,00	R\$ 52,00
MARRETA	1	Unid	R\$ 35,00	R\$ 35,00
PINCEL TIGRE 2"	1	UNID	R\$ 7,50	R\$ 7,50
Vergalhão 40mm a cada 20 cm	7,88	m²	R\$ 260,00	R\$ 2040,00
4 pilares de 30x30 20mm	4	Unid	R\$ 102,00	R\$ 408,00
Cimento	5	Unid	R\$ 45,00	R\$ 225,00
Areia	10	Unid	R\$ 4,50	R\$ 45,00
Seno	15	Unid	R\$ 6,00	R\$ 90,00
Total:				R\$ 2948,28

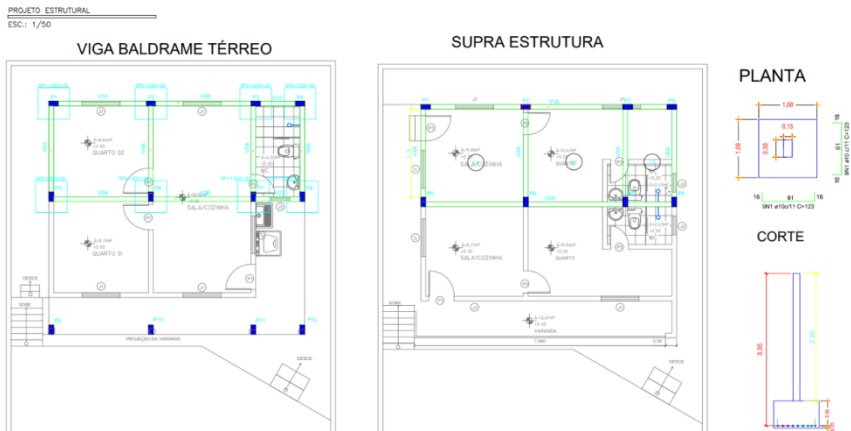
MÃO DE OBRA	R\$ 615,60
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The caveat with the report is that, given the evidence gathered, it was possible to judge planning conditions and determine the parameters that will help the owner to make adjustments, albeit in part to minimize problems and act to adapt and improve the building.

In response to the request for inspection and technical survey, the architectural project was also prepared with details of the residence and already projecting the modifications that will be incorporated. Figure 07 shows cutouts of the floor plan and complementary projects to highlight the breadth of the project made.

Figure 7- Cutouts of the architectural and complementary design of the single-family residence





The architectural project and complementary projects bring important elements for the readjustment of the residence that will be promptly handed over to the owner, who will provide the means for the allocation of materials and labor.

### 3 FINAL CONSIDERATIONS

Intervention in established systems that are prone to the maintenance of addictions and habits is what demands care from the performance team to diagnose problems and suggest solutions. The study presented here proved to be valid and enriching, as it allowed us to act independently in determining the problems caused by construction errors and situations of exposure to degrading factors in a single-family house.

The identification of problems is only an instrument to allow the insertion of new formulations, it provides the engineering professional, especially the student, with the need to carry out a grounded study, with the use of valid instruments that accredit the insertion or indication of a problem or a given solution.

Experimentation with practice, with the exercise of acquired knowledge or that which had not yet been acquired but which, in need, was cataloged and listed in the structure of guiding elements of the diagnoses. The target residence of the case study carried out is a mirror of many residences within Manaus and other cities that have neighborhoods in their peripheral region that arose from squatters, improvised constructions and with low technical knowledge.

It should be emphasized that it is not the entire structure that has problems that are reported in this study, but that part of it becomes weaknesses arising from a structure that is based on certain imaginable safe contributions. Science advances and exposes resources to be used in favor of society and their use is the role of professionals in the area.

Encouraging the people to make correct use of scientific and technological attributes is what makes science the gateway to social adjustment, which allows generations to talk to each other and reformulate situations that have stood for centuries in anticipation of paradigm shifts and behavioral adjustment.

As a proposal for future works, the suggestion is to enhance the skills of being able to associate innovative materials and that can improve the cost-benefit ratio. The initiative to make people aware that their homes need technical and specialized support can reduce the risk of accidents, favoring a better quality of life and valuing professions. Thus is written a new history for humanity.

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