

Cracks Studies Case of Buildings in Sinop City - Brazil

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Abstract The building structures are objects of interest in Civil Engineering, appropriate to its importance in sustaining and preserving the building. The monitoring of their behavior can occur for analyzes on structural elements, directly, or other structures for monitoring the building. Such situations encourage the improvement of new techniques for structural evaluations through measurement service elements and interpretation of monitoring data. Amid this context, the present study aims to analyze, diagnose, classify, expose the possible causes and possible solutions of the problems of the buildings studied pathological located at Sinop – MT, where the study included various types of buildings from earthen, 3, 11 e 19 pavements, as residential construction, public and private educational institutions, or for use in the construction step, all intuited with the larger scope of diseases in the municipality, identifying whether or not problems that could compromise the safety criteria, resistance and good performance of buildings.

Keywords Inspection, Assessment, Intervention, Pathologies

1. Introduction

The construction industry is constantly developing, both in materials, techniques and equipment. However, this growth is not always accompanied by labor, which can lead to constructive incompatibilities, giving rise to some pathological problems [1].

In midst of this conception and innumerable pathological problems occurrences in buildings, the study seeks identify the nature, origin, directions, intensity and incidence of pathologies, besides diagnose and prognosticate, as well as to verify structural properties interference of buildings [2].

There are several factors that prove the importance of study, and it can be used from a data base to morphological behavior knowledge of cracks in buildings, as well as use by professionals of area in form of strategic planning, using the material in a way to correcting greater prevalence failures and intensity detected, factors that often occurs due to lack of technical-practical knowledge. This results in problems that can be corrected in several phases and a building, both in the design, execution and building use, given that the literature gives indications that sooner their diagnoses and their possible solutions are started, less is the monetary value involved [3].

1.1. Theoretical Grounding

Civil Engineering is an area of knowledge in constant development, whether in materials, such as the use of new wood species, or even the techniques employed, such as the use of more modern machines and equipment as well as more developed project methods [4]. Although for thousands years man has been increasingly seeking materials development, techniques and methods, always aiming at consolidating technology, encompassing design phases, analysis, calculation and structures detailing, materials technology and the respective constructive techniques still have several limitations related to involuntary failures, malpractice, deterioration, irresponsibility and accidents, which tend to lead to structures losing some their characteristics, presenting a poor character for what was projected [5].

Helene [7] describes pathology as the study of symptoms, mechanisms, causes and origins of civil constructions effects, that is, as the study of parts that make up the problem diagnosis.

Among the various pathological manifestations that occur in buildings, Thomaz [8] highlights the fissures as being the most important due to three aspects: warning of some serious problem in structure, construction performance compromise in service and the psychological constraint that cracking on their users.

According to Ripper and Souza [9], in durability terms, fissure is the most harmful pathological manifestations; as it facilitates the aggressive agents access to the reinforcement bars in armed masonry, causing corrosion. Also facilitate the moisture entry, causing discomfort for the building user.

Fissures take the lead in symptomatology in buildings. Its

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identification and causes are vital importance in defining the appropriate treatment for recovery. They explain that cracking main cause is the differential movement of building materials and components. It is important consider the building components dilation/contraction, providing means that allow these displacements or elements to absorb part of generated voltages, reducing to acceptable levels [2].

Because of this, the pathologies study from their manifestations characteristics allows a broader and more satisfactory knowledge of the origins, subsidizing the studies in recovery phase, maintenance and contributes to an perception improvement of buildings production processes stages, making possible the preventive measures adoption [10].

1.2. Cracks Classification

Cracking is a phenomenon intrinsic to reinforced concrete and has been the analysis subject by technologists of all times and, perhaps for this reason, cracking is currently one of the most striking symptoms in civil construction [6].

In reinforced concrete structures, cracks will always occur because of concrete low tensile strength. However, its opening should not damage the element durability or appearance. Therefore, we must assign the limits imposed for fissures opening, yet they depend on ambience aggressiveness and the protection degree of structural element [11]. For these reasons, ABNT NBR 6118 [12] adopts limits for fissures opening.

In the middle of this, cracks can be classified according to different criteria, i.e.: aperture, activity, shape, causes, direction, tensions involved, type among others. According to their opening, they are classified as thin, medium and wide, but, nevertheless, other authors propose different scales, also according to their openness, such as: very slight, mild, moderate and severe; or very mild, mild, moderate, extensive and very extensive. According to their activity, cracks can be active and passive, distinguishing themselves from being or not having variations in their opening [2, 3, 11, 12].

Another classification form is according to its form, where it can be isolated or differentiated, being defined by the predominance in its direction. Or even, by its propagation direction, being: vertical, horizontal and inclined. Lastly and not least, according to its causes, whose main formation factor is: overload, temperature variations, retraction, expansion, deformation, settlement, chemical reactions and constructive failures [13].

1.3. Phases of Occurrence of Pathologies

Often, the typical configuration, size, and magnitude of a fissure allow one to speculate its probable cause. With this approach, we can catalog the most frequently encountered configurations of fissures in buildings, from their most frequent causes [14].

Pathologies have their origins motivated by errors or failures, which occur during various activities inherent realization to the civil construction process, divided into

three basic stages: conception, execution and utilization [2].

The pathologies can be found in most buildings, being with a greater or lesser degree, causing concerns both in aesthetic and functional aspect of the structure. However, indications of scientific community that sooner its diagnosis is carried out, greater are the solution chances with lowest possible cost, which justifies the need to diagnose and study the problems involved in this research [15].

1.3.1. Structure Design Phase

According to Helene [7], failures that originate from poor preliminary studies or even erroneous projects, are mainly responsible for the higher construction processes costs or for problems related to construction use, while the errors generated during projects engineering endowments are responsible for implementation of serious pathological problems and may be as diverse as: inadequate design elements; compatibility lack between structure and architecture, as well as with other civil projects; inadequate materials specification; insufficient or wrong detailing; non-executable constructive details; standardization lack of representations and design errors. The following are defined:

a) Concrete contraction cracks

According to Rojas *et al* [1], this is the first cases in which cracking occurs in executing process of a particular structural piece, it occurs before concrete cure due to excessively rapid water evaporation that was used in excess to make the material. Helene [7] adds that this process is more common on large surfaces such as slabs and walls. These cracks occur parallel to each other and are at an angle of approximately 45° with the corners, being, in most cases, superficial. However, depending on the slender pieces in question, they may even section it.

b) Cracks by concrete settlement with adhesion loss of the reinforcing bars

For Rojas *et al* [1], this cracking form always occurs due to concrete launch, when it is prevented from settlement on lower layers, due to shapes presence or reinforcement bars. The cracks formed by concrete settlement follow the reinforcements developments and cause the creation of called "wall or shade effect", which consists in the void formation below the bar that reduces concrete adhesion. If the bar grouping is very large, the cracks may interact with each other, generating more serious situations, such as total adhesion loss [16].

c) Concrete retraction cracks

These cracks arise as an obstruction consequence of retraction deformations or element thermal expansion. The wall is concreted over an already hardened concrete base. When the concrete in the wall undergoes retraction, its movement is restricted by the base. This results in tensile stresses on the wall, which produce cracks. These cracks can also occur when the concrete in the wall undergoes a cooling after being preheated on a very hot day, with additional heating due to the cement hydration. These cracks can also

arise in slabs, elevated reservoirs and other structures types. In many cases, cracks arise even before the forms are removed, that is, when structural element is not yet subjected to loading action [11].

d) Fissures by temperature variation

The temperature variation effect on buildings, especially exposed structural pieces and those on the last pavements, may present differential deformations in structural elements, causing cracks in masonry, and these will be more accentuated at the top of the buildings, gradually decreasing in lower pavements. Special attention should be given to roof slabs, especially those without necessary thermal protection. This fact will cause deformations that will be felt, initially, by masonry, and then by reinforced concrete structure itself [17].

e) Structural elements deformation

The structures deformability generates movements that cannot be accompanied by rigid construction of masonry walls, introducing compression, shear and shear tensions in them, which can cause cracking [8].

The main influence structures deformation of reinforced concrete on masonry happens by the slabs and beams flexion. In general, other deformations caused by compression, shear or twist requests are less significant. The slabs and beams bending occurs in general by action of their own weight, non-structural and accidental permanent loads, slow concrete deformation and external lateral loads (wind action) [18].

The cracks caused by structures deformability may take different configurations: arc cracks due to support beam deformation, cracks inclined by support and upper beams deformation, cracking by upper beam overload, cracks inclined by deformation of beams and slabs in balance, horizontal cracks due to roof slabs deformation, among others [8]. For this reason, ABNT NBR 6118 [12] sets limits for structural elements deformations.

f) Foundations settlement

Several factors are pointed out as causes for differentiated land settlement and, consequently, for buildings cracking. They are: workload greater than the permissible soil load; soil homogeneity lack; water table retraction or water incorporation into land; surroundings and neighborhood loads influence; support and load differentiated conditions, such as buildings of variable height or use of different foundation types; overlapping; erosion, excavation or underground failure; adjacent vegetation influence or tubing; freezing; floods; vibrations [8].

Fissures due to foundation settlement have a predominantly inclined orientation and are therefore often confused with deformation cracks of structure reinforced concrete elements [8]. Another characteristic of foundation fissures is the tendency to locate near the ground floor of the building, although this is not a rule [19].

Ayensa *et al* [20] state that cracking settlement will be even more significant when reinforcements are defective or even when they are poorly positioned in element.

g) Chemical reactions

The cracks caused by chemical reactions are predominantly horizontal and occur by the grout joint expansion caused by the undesirable chemical alteration of its constituent materials [8].

Although the building materials should be chemically stable, it is common to have excess soluble salts in mortar joints, causing expansive reactions in crystallization process. The most common are given by cement reaction with sulphates, the limes delayed hydration and the aggregates hydration containing clays [21]. These cracks will occur predominantly along the horizontal masonry joints, where there is a greater amount of mortar and may also manifest in vertical joints and present efflorescence. The horizontal cracks occur preferably at the top of the walls, where the masonry weight influences is lower [8].

1.3.2. Execution Phase

According to Bauer [22], once construction is started, several errors of any more diverse nature can occur, for example: working conditions lack; not labor professional training; deficiency in execution quality control; materials and components poor quality; irresponsibility.

a) Shape movement and shoring

According to Rojas *et al.* [1], cracking derived from forms movement may result in workpiece sharp deformation, causing alteration in its geometry, with load bearing capacity loss and, thereafter, development a characteristic cracking condition.

b) Constructive detail

The fissures originated by constructive details occur due to the deficiencies presence and errors in buildings execution process, not taking into account materials physical properties, impermeability and constructions, as well as correct execution forms and detailing projects [13].

1.3.3. Usage Phase

After completion of construction and execution stages or even when such steps have been achieved the expected quality, structures may present pathological problems whose origin is reflected by the misuse or lack of an adequate maintenance system due to user low technical knowledge [22]. The same author mentions that pathological problems caused by improper use can be avoided through information to users, mainly about construction limitations. Some ways of establishing pathologies:

a) Actions applied (localized)

This includes the various cracking processes resulting from exceptional actions applied locally, mainly by vehicle or boat crashes, or by explosions [1].

b) Concrete disaggregation

For Padaratz [23], it is understood as disaggregation the slabs physical separation or concrete slices, with loss of monolithism and, in most cases, also ability loss to mesh

between the aggregates and binding function of cement. As a consequence, it is assumed that a piece of unbundled concrete sections will lose, either locally or globally, the bearing capacity.

c) Biological attacks

Several biological actions (vegetation roots, microorganisms, etc.) that enter into the space within a structural mass, penetrating the concrete and finding environment proper to its development, generate internal tensions and fracture the concrete [7].

In cases where the cracking is significant or concrete permeability is high, carbonation penetration is accelerated, following the orientation given by cracks direction, towards the reinforcing bars, inevitably implying corrosion [7].

d) Overloads

The buildings with utilization overload higher of utilization yonder considered in project are susceptible to excessive deformations and, consequently, crack [24].

e) Detaching or detachment in mortar coverings

The detachment occurs when the coating mortar is completely released from the substrate. Partially, it also occurs between protection layers (roughcast and plaster), providing a detachment, and can be recognized by the hollow sound, when touched. It is noteworthy that, as the displacement advances, cracks appear and, at the most advanced stage, total detachment occurs. The solution for all detachment cases between layers is reconstructing the entire coating, because the defect generalizes all over the surface and cannot be predicted when it will stop [6].

f) Efflorescence

According to Uemoto [25], efflorescence means formation of saline deposit on materials surface. Usually, it causes no damage greater than the resulting bad appearance, but there are cases where its constituent salts can be aggressive and cause deep degradation. The visual modifications are more intense when there is contrast between salt and the base on which it is deposited, as for example, the formation of white efflorescence on ceramic brick.

g) Moisture

According to Verçoza [6], humidity is the most frequent pathological manifestation in buildings. It is cause or the necessary means for occurrence of most buildings pathologies. Still the same author says that it is indispensable for mold appearance, efflorescence, oxidation, paintings loss, plastering and even structural accidents cause. In general, moisture can have the following origins: during construction, by capillarity, by rain, resulting from network leakage and condensation. The moisture originated during building construction is maintained for a certain period after the work is completed and, in some cases, takes up to six months or more to dry. By capillarity are those with soil water absorption by foundations, migrating to the walls and floors. Moisture due to infiltration from rainfall penetrates buildings through their constituent elements. Those from leaks in

distribution system and/or water collection of buildings can be difficult to locate and correct, often covered by building.

2. Material and Methods

For this work preparation, some materials were needed both in bibliographic review stage and in field and analysis stages, where for bibliographical review had as a source of material repositories on the web and in State University of Mato Grosso collection, such as: scientific articles, monographs, ABNT standards, books, dissertations and theses. Of these, they were the basis for understanding building pathologies concepts, especially themes related to fissures morphology. In addition, a 18.2 megapixel Sony semiprofessional camera was used, whose resolution was able to reliably extract the features of interest object for photographic report, as well as some materials such as microscope slides, a reduced thickness material used to measure cracks activity, where in case it expressively moves the material enters into rupture.

In this study, case studies were carried out in buildings located in Sinop municipality, in the northern region of Mato Grosso State, analyzing and discussing several situations, such as properties and pathologies characteristics, both of which aim to enrich and improve the research reliability, exposing its diagnosis, that is, demonstrating the variability and consequences of fissures causes.

The first data is Building A, and its nomenclature is thus defined in order to preserve building identity. The object of study is composed by 1 floor, being headquartered a public higher education institution, located in a residential district of municipality. The construction has more than a decade of use, presenting several pathologies types, which originated from design, execution and construction use. Among some pathologies, various moisture problems, expansion joints, coatings retraction and structural elements deformation which, in some places, causes an abandonment aspect.

Building B, located in commercial center, has several vertical buildings in neighborhood, composed by 3 floors and about 10 years of construction. In addition to being leased for public judicial system, in which several pathologies were found and most of which are likely to have occurred through failures in constructive process, such as lintel and counter lintel lack, in addition to the others such as coatings retraction, structural deformations and humidity problems.

Building C, characterized by two juxtaposed structural masonry, residential, ground, covering with metallic structure and thermo-acoustic tile, located in a neighborhood near the center of studied municipality, being in finishing phase. However, it already presents some pathology, among them it is possible to emphasize, coating retraction cracks, dilatation joint lack and also foundations settlement.

Building D, comprised by a private higher education network, located relatively far from urban center, presents several pathologies, such as beams deformation, coating

retraction, and construction cracks, all result of executions and low quality maintenance.

Building E, located near urban center in a residential and commercial area. It is a public higher education institution with more than 20 years of construction use and not always with its preventive maintenance in days. The construction presents several pathological manifestations, originating from conception phase such as reinforcement and constructive details not efficient, as errors in execution and not less frequent manifestations due to its use. During visits of inspection preparation, in order to prepare the future diagnosis, a lot of pathologies were found, such as moisture problems, coating retraction, lintel and counter lintel nonexistence, foundations settlement, structural deformation and etc.

No less important is Building F, consisting of 11 floors and located in central urban area. About 10 years of its construction, it has a commercial character and is surrounded by vertical buildings, besides also presenting some pathology, such as cracks due to constructive errors, soil densification and structural deformations. In rainy season, when the water level table appears, according to users and apartment manager they mention that a pump is necessary to transport the water accumulated in place parking. The inspections in this building were restricted in the exterior, ground floor regions and building subsoil, due to non-interference in use ways and guaranteeing the administrative users principles.

In order to carry out the case studies, 8 works were used in Sinop-MT municipality, being 5 of pavement and one of three, eleven and nineteen pavement, totaling approximately 1213 pathologies, where they were classified and graphically exposed by their directions, incidences, causes and intensity.

The development of this work takes place in three stages. In the first one, defined as Inspection, where visual inspection was initially performed, the main objective of which was to collect data, identifying all symptoms, as well as their locations and intensities. The second stage, responsible for Diagnosis, explains the influence of any information on global construction behavior. Continuing, the last and third stage consists of Prognosis, that is, it mentions the consequences that will arise if the corrective measures for problem elimination are not made, indicating what are these corrective measures to be executed in the building.

The inspection objective was to rigorously investigate the object study characteristics, in several ways, among them: age, use, visual examination, photographic memorial, and qualitative and quantitative structure analysis.

Already at this stage, we tried to understand the entire case evolution process, identifying its most probable causes and effects. In some cases, it is possible to determine the nature and pathology origin, due to constituent materials, characteristic resistance, quality and construction characteristics, age of problems start, previous repairs, possible changes of use, etc., performing an interpretation of each given, raising and understanding how the structure works as it was constructed, how it has reacted to aggressive agents, how and why

problems have arisen, where each interpretation is critically analyzed for study truthfulness and trustworthiness.

Once the pathology diagnosis in question has been established, we proceed to define the conduct to be followed, in other words, the choice of curative measure to be adopted for each case. However, before any action is taken, it is necessary to survey the evolution hypotheses of the problem, that is, the case prognosis. For prognosis preparation, the problem was analyzed and studied, based on pathology morphological and visual characteristics, obtained by photographic essay, being able to obtain possible alternatives of failure development. This study is important, not only for simple cases of diagnoses and obvious repairs, but mainly for complex problems that are difficult to solve, because in several cases, the resolution possibility is practically remote, develop only measures of situation control, that is, avoiding the aggravation of the same.

3. Results and Discussion

The first data to be discussed is Building A (Figure 1). This building is characterized by a diagonal cracking already with the coating puffing, having as possible causes may be the foundation elements deformation. This pathology type was very much found in study object, because the building is composed of sets of rooms without links between them, in which some of them were constructed simultaneously, giving indications that the mistakes were spreading equally.



Figure 1. Building A

Figure 2 below demonstrates a volume associated with one of building sets, and can observe humidity problems. The diagnosis process evidence the structural movement of upper and lower beam, however the flat masonry did not follow the movement, causing opening. Consequently, the aggressive agents of medium begin to deteriorate the structure, causing oxidation in reinforcement and may cause structural properties loss.



Figure 2. Building A

Building B can be analyzed by Figure 3. The pathology has its direction predominantly horizontal and from one end to the other of the wall. Its probable cause is the first slab backing beam deformation, which resulted in pathology in the connection between masonry and the structural element. The pathology was monitored with fixation of a glass slide, in which it did not collapse, concluding that the crack is passive. However, it is primary importance not only monitoring the local where cracking has already occurred, but of all the buildings, remembering that the preventive maintenance is much more effective than corrective one.

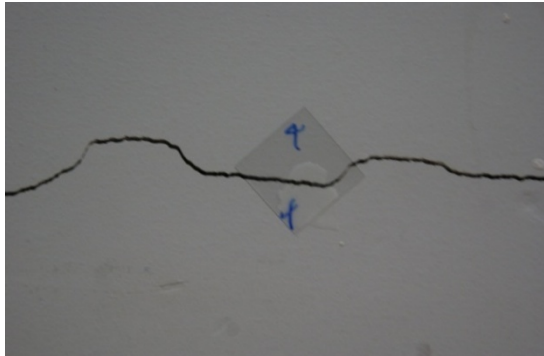


Figure 3. Building B

Figure 4 just below, also the same building on its second floor, has a 1.5 by 10.5 meters balance. It is probable that for joint reasons such as structure deformation of balance and element load concentrated, may have caused a foundation settlement beyond predicted, characterized by fissure with predominant diagonal direction, having as origin the joining of elements beam-pillar and being passive. Preventive monitoring is advisable, as stated above, and it is advisable to insert pillars in balance region, increasing the bearing capacity and, thus, better displacements restricting.

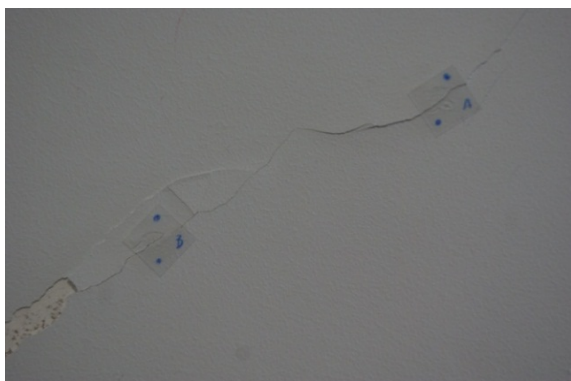


Figure 4. Building B

Building C, represented by Figure 5, shows the pathological style often found in the building, in which the crack was present on both wall sides. Due to the external face is exposed to high solar incidence, it contributes to retraction cracks proliferation, besides the expansion joints absence, inducing active loads in masonry to create its own transmission path. Also present in diagnostic process was the pathological incidences detection of foundation settlement,

due to design phase inconsistency in which it was designed with use of shallow foundation and the grade beam nonexistence, but a block of cast structural masonry concreted with incoherent reinforcement, not being sufficient for requested forces, causing excessive deformations in its elements.



Figure 5. Building C

Construction D (Figure 6) gives indications of structural element movement, causing openness between structure and gasket masonry, its causes being more likely the slab retraction and support beam deformation.



Figure 6. Edification D

Figure 7 and 8, from the 'D' and 'E' buildings, identify vertical predominant fissures. The most plausible hypothesis is that correct reinforcement was not used (shear forces), so that its structural capacity was guaranteed, causing pathology.



Figure 7. Edification D

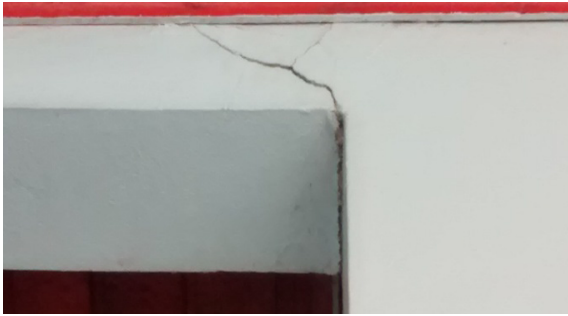


Figure 8. Building E

Building E (Figure 9) can be proven the counter lintel non-existent. The masonry sealing was not sufficient to ensure the requested stresses, causing cracking. The fact can be verified in several places of building, and it is necessary punctual reinforce.



Figure 9. Edification E

Figure 10 of the same construction of figure above, can be proven a horizontal pathology, whose most probable origin is slab retraction or structural element deformation. The same could have happened for several reasons, among them the overload on backing beam or even the low resistance of present concrete. This pathology is located in a set of same institution, composed of laboratories set recently built, since even though it does not have a long time of use; it already presents pathologies equivalent or superior to oldest building set.



Figure 10. Edification E

By Figure 11 other factors and building properties, as well as the bearing capacity of some structural elements, can be analyzed and discussed. Given the building age, some cracks and pathologies that have not been corrected on preventive maintenance will have to be carried out in a corrective way, as the maintenance lack causes the aggressive means to advance, which appropriate the satisfactory environment that

the opening is found, causing moisture problems, oxidation, retraction and coatings expansion, in which the whole structure is damaged more and more, losing each day more its characteristics and structural properties.



Figure 11. Edification E

No less important is Building F (Figure 12), in which cracking may have occurred in several ways, among them: beam deformation due to some use overload, or even soil thickening, causing all structure movement. Because masonry has low tensile strength, creating cracks is inevitable.



Figure 12. Building F

The soil movement is something that must be taken care of, especially in the region where the soil has low resistance and very high water table. In Figure 13, where the foundations settlement together with possible thermal movements in structural elements can cause cracking. In the case in question, cracking is present in structure, in which it gives evidence of pillars joint presence, where among them the cracking occurred due to the mortar retraction and in structure displacement, being of primary importance its monitoring by virtue of responsibility that the pillar has, for example, transferring all the efforts of the slabs and beams to foundation elements.



Figure 13. Building F

Among the several case studies listed above, it was necessary to formulate Figure 14, showing the main sources

of fissures in buildings studied, and it can be used for a goal plan, since the main origins of pathological problems are already known, providing an improvement in technological control issues of buildings.

In view of Figure 14, it can be pointed out that the greatest presence of cracks found is due to constructive details failures, the same is due to projects and labor poor quality, non-effective projects, supervision lack by designer, where everything tends to pathologies that could be avoided in a more rigorous control. On the other hand, the second fissures type most frequently encountered are thermal movement, since our region has a very high temperature; another factor that can also cause thermal movement problems is the poor mortars quality, where due to the retraction it tends to crack. The third most common pathological type is foundation settlement, which may be a reflection of low soil resistance, along with foundations failure, beyond which most buildings have more than a decade, where not always the elements were dimensioned according to technical standards. Finally and not less relevant are the cracks whose predominant origin is structural accommodation, cracks whose characteristics related to structure deformation, and may have occurred due to failures in reinforcement, design or even in execution.

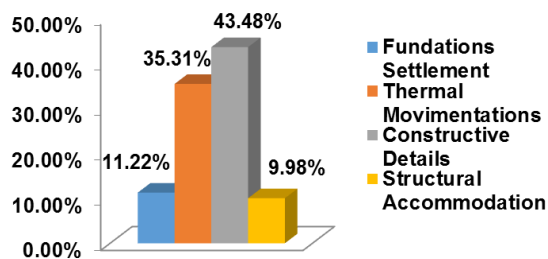


Figure 14. Pathologies incidence

In the cracking process, its opening can occur in several ways, being usually classified by literature in vertical, horizontal, diagonal (inclined) and mixed, as can be verified by Figure 15 just below. The opening direction is often linked to its origin, for example, mixed fissures, whose direction is composed of others all, very close to the geometric mosaics form, very present in buildings frontage due to the mortar thermal movement, that is, the phenomenon also known as retraction, or even in fissures whose predominant direction.

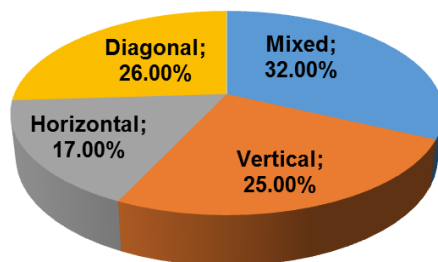


Figure 15. Cracking direction

The present work also had the objective of analyzing the pathologies by pavements levels, distinguishing themselves

in 1, 3, 11 and 19 pavements, in which the present Figure 16 had the intention to expose the cracks quantitative analysis, being able to be analyzed that in projects with fewer pavements, such as the 1 and 3-storey buildings, the most frequently encountered fissures are those of constructive details and thermal movement, considering that in smaller risk works hired labor is not always qualified. Due to the search for a cheaper service, or even in materials quality, all aiming reduce and cut costs, all of which are reflected in useful life, safety and building durability, having a greater number of constructive detail fissures due to suitable structural elements lack. However, frequency are reducing according to greater floors number, this factor is due to the better quality of workmanship involved, or even in the best technical follow-up.

Some data tend to remain high, as in the thermal movements case, since the northern region of the State of Mato Grosso has a high solar incidence, varying from a very dry and humid climate in each part of the year. Some have to maintain a smaller discrepancy in buildings with lower floor level, as in foundation settlement case, considering that the lower load applied to foundation elements, lower the chance of these problems occurring.

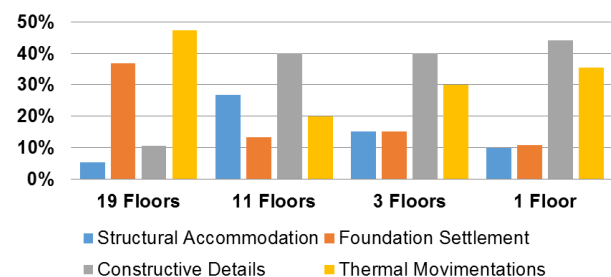


Figure 16. Cracking intensity

According to pathologies nature listed in Figure 15 and 16, located just above, it is possible to define the prognostics, that is, to indicate possible correction forms, to guarantee the preservation of building structural capacities. Since the pathology nature defined as thermal movement, the main factor to be analyzed is the mortar characteristics, since a trace with unsatisfactory water/cement ratio tends to provoke such cracks, due to the binder excess, as in the fine aggregate excess. Structural accommodation is delicate, because it is necessary to investigate several factors that can compromise the entire structure, such as F_{ck} , reinforcement, elements geometric characteristics, current overload and design overload, materials quality used as steel and concrete, as well as deformation measurements. Since the fissure originates from constructive details, we must analyze some factors such as the lintel and counter lintel use, as it is also the case of expansion joints, which is created by architectonic dispositions, and if it does not take place its tensions tend to dissipate by least energy path. Also very much found during the investigation process and very important are the foundation settlement cracks in which one must be analyzed the tensions acting comparing with the soil tensions and foundation elements geometries.

Considering the Buildings from "A" to "F", the possible causes and solutions are presented in Table 1.

Table 1. Causes and possible solutions

Cracking	
Cause	Possible Solution
Foundation Settlement	Analyze the soil tensions acting, foundation elements reinforcement, structure enrigement.
Thermal Movimentation	Open, fill with polymer mortar, apply a broken saddle (tape), tow again and paint.
Constructive Details	Lintel and counter lintel creations, connections reinforcement.
Structural Accommodation	Structure reinforcement, better movement restriction.

4. Conclusions

The results indicated the fissures predominance caused by constructive details, followed by thermal movements, as a result of workmanship poor quality, materials quality and technical monitoring, also indicated that the buildings characteristics, such as floors number and structure type, influence the configuration of observable cracks.

We can also report the indexes of the pathologies by means of the number of floors, considering that in buildings of the floors and of 3 floors, fissures of thermal movement and by constructive details are more found when compared with buildings with 11 or 19 floors, reflection of services, unsuitable materials and equipment, already structural accommodation fits and foundation repression are less present, due to the lower loads of foundations and more simplified structures.

Another important factor to be analyzed in buildings is cracking direction, where most of the time we can estimate their nature, which facilitates the structural diagnosis process.

It is concluded by the applicability of typical set configurations adopted and methodology used, judging them to be useful instruments for cracks survey in current constructions, and that both, the incidence and intensity, analyzes were shown to be complementary in cracking depending on the desired research objectives, being Incidence the most indicated in search for incidence scenarios and identification of possible manifestations, and Intensity more appropriate for determination of occurrences number.

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