Chapter 152

The effects of neglecting the study of soil sounding on foundations

https://doi.org/ 10.56238/devopinterscie-152

Lyvia Monteiro Advincula de Souza
Universidade de Vassouras
E-mail: lyviamonteiro14@gmail.com

Beatriz Melo Carvalho
Universidade de Vassouras

Cláudio Bonfante de Oliveira
Universidade de Vassouras

ABSTRACT
Soil sounding aims to bring essential information so that the structural calculator can design a structure that effectively meets the needs of each type of construction. However, in numerous situations (especially in small constructions) this information is neglected since the owner usually reports that it is something impractical. Among this information obtained, is the designation of the type of soil, the level of the water table, the layers of the soil, and their respective resistances. Obtaining this information, it is possible to define the type of foundation most compatible with the construction in question, as this is one of the crucial parts of construction since it is where all the loads of the building are supported, therefore it plays a considerable role in the staticity of the building. There are constant problems in the foundation because this previous study of the soil has not been carried out. As a result, professionals rely on the study of soil sounding, a method of geotechnical investigation that helps in the identification of soil layers. This work aims to show the effects of negligence in the study of soil sounding in foundations.

Keywords: Oil sounding, Problems in foundation, Type of soil, Staticity of structure.

1 INTRODUCTION

The great population expansion, since the beginning, causes an increase in the demand for buildings, directly linked to technological advancement resulting in the expansion of civil construction. However, nowadays, it is still notorious that many constructions with varied pathologies arise from flaws in the project, such as, for example, the non-performance of sounding.

During the construction process, to ensure the necessary safety for the balance and stability of the structure, it becomes indispensable to carry out drilling in the soil since it is possible to discover the type of soil through the samples, the mechanical behavior of the soil, determine the resistance of the soil to stresses and these data help in the positioning of the construction within the terrain and, also in choosing the most appropriate foundation avoiding pathologies and enabling a more efficient work. According to SCHNAID (2000), the cost for the execution of the survey in Brazil varies from 0.2 to 0.5% of the total cost of the work, and at this stage is where the geotechnical information essential to proceed with the project is found. Without doing the survey, there is no way to know the terrain in the civil construction question

and, therefore, the option for the type of foundation and its sizing will not be correct, generating additional costs due to the emergence of problems of recovery from the impasses caused.

In choosing the foundation that best suits the soil conditions analyzed in the survey, it is necessary to take into account the forecast of permissible loads to keep both the infrastructure and the superstructure safe. The properly designed foundation must distribute the efforts in such a way that it does not generate tensions that cause ruptures and that does not stimulate repression. In some cases, the buildings require a shallow foundation, such as the shoe, while in others, as in the elaboration of a bridge, pipes are used. This is possible due to the diverse functionalities of the foundations.

Based on this information, the general objective of this study is to emphasize the main reasons for conducting the survey, even raising the cost a little, since, if it is not carried out, the losses will be greater.

2 SURVEY

The survey, as previously stated, provides the basic data for the stages of the work, choice of foundation, angle of slopes, and stability, that is, it is an essential step for the effective realization of an engineering project. These data are crucial for making decisions regarding the project, ensuring a more efficient and economical execution, with information on the positioning of the construction on the ground and the best type of foundation, thus avoiding the emergence of pathologies for the work. (BELINCANTA, 1985).

Percussion probing

It is a method for soil investigation, using a sampler to ascertain penetration resistance indices, obtain soil samples, determine water levels, and perform various tests. This survey model should be identified by the acronym "SP" and an indicative number, it is also recommended that it determines hundreds of different structures of the work.

To determine the number of holes in this test, just follow the list in Table 1:

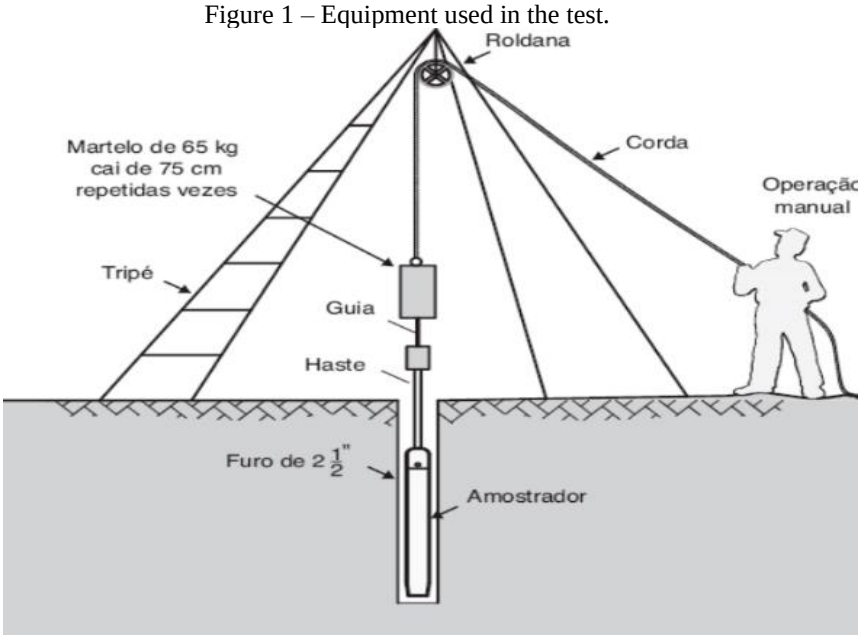
Table 1 – Numbers of holes per m²

Número de furos	Área de construção	Condição
2	200 m²	Construções de até 200 m²
3	400 m²	Construções de 200 até 400 m²
1	1200 m²	1 furo a cada 200 m² para construções de até 1200 m²
1	2400 m²	1 furo a cada 400 m² para construções entre 1200 até 2400 m²

Source: Authors. (2022)

Based on NBR 6484/2001, in addition to the sampler and trepans, which are used alternately, for the sampler to collect samples penetrating 45 cm in 3 stretches of 15 cm (Figure 1), recording the number of strokes required in each of these three parts.

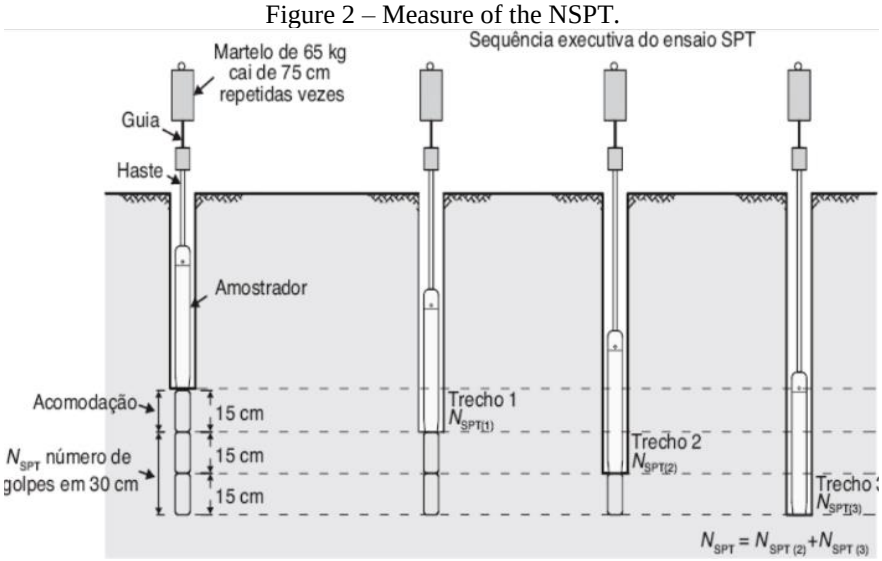
Figure 1 – Equipment used in the test.



Source: Foundation Engineering – Paulo José Rocha de Albuquerque (2020).

The number of beats required, discounting the first 15 cm, is called the penetration resistance index (Figure 2). However, it is possible to perform the excavation using a washing trepan. The procedure occurs with the digging of the sampler, using a hammer that, in free fall, plummets by 75 cm, respecting the stretches of 15 cm and obtaining the results of NSPT (which are the numbers of blows).

Figure 2 – Measure of the NSPT.

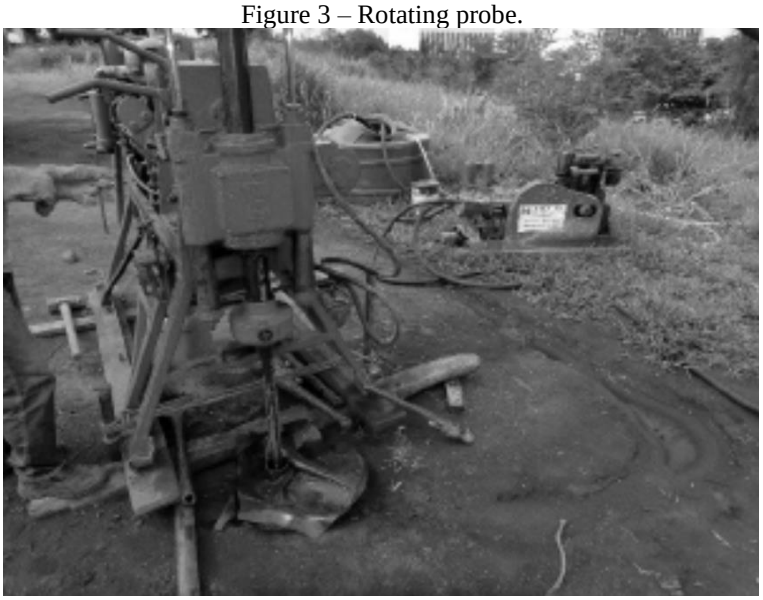


Source: Foundation Engineering – Paulo José Rocha de Albuquerque (2020).

Rotating polling

This type of drilling is commonly used in drilling rock and high-strength soils, and it is understood that drilling is carried out through rotational movements. The sample that is collected is called a testimony and, through it, it is possible to analyze the quality (RQD).

Figure 3 – Rotating probe.



Source: Foundation Engineering - Paulo José Rocha de Albuquerque (2020).

Mixed poll

As its name suggests, it is a poll that combines the two mentioned above. Using percussion probing for sections in soil and replacing with rotating probing when the soil has high resistance or when it is rocky soil.

Protrus probing (manual or mechanical)

The auger, in the market, is seen as the most economical, fast, and easy to perform, so it is performed only in the soil layers with low resistance and that is above the water level. The sample is taken every meter, analyzing the changes in the material. This method is chosen to indicate the level of the water table. NBR 9603/2015 specifies the types of augers and materials necessary to carry out this process, and also how it should be done.

3 FOUNDATION

Foundation is a set consisting of the land (soil massif) and the structural elements of the foundation, where the entire load of the building is transmitted to that soil.

Every engineering work requires a solid and fixed foundation to be founded. An apartment building, shed, shed, bridge, viaduct, highway, railway, earth or concrete dam, port, airport, water treatment plant,

etc., can be called engineering work. The solid and fixed base is understood as a support that grants effective security in what refers to rupture and deformations.

It is essential to emphasize that the soils located under the foundations deform, and, because of this, all the foundations suffer repressions as a result of the addition of stresses inserted by the engineering work on the foundation ground and that every addition of stress is equivalent to a deformation of the ground. However, the admissible displacements/setbacks that each building can carry without future damage mustn't be exceeded.

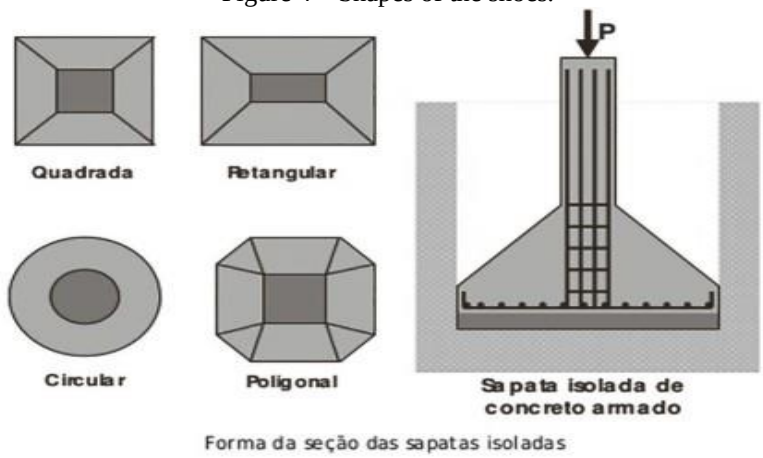
3.1 SHALLOW OR SUPERFICIAL FOUNDATION

According to NBR 6122/2010, the surface foundation is an element that transfers stresses distributed at the base of the foundation to the soil massif. They are subdivided into: shoes, blocks, and radio. A shallow or superficial foundation is feasible when starting from 1m below the implantation quota of the last level of the construction, you have soil with resistance and deformability compatible with the structure.

Shoes

Shoes are understood as being a support element made of reinforced concrete and can be rigid or flexible, resisting especially by bending. They can adopt any shape in plan (figure 4), but the most common are square shoes (B = L), or rectangular and running (L>B).

Figure 4 – Shapes of the shoes.



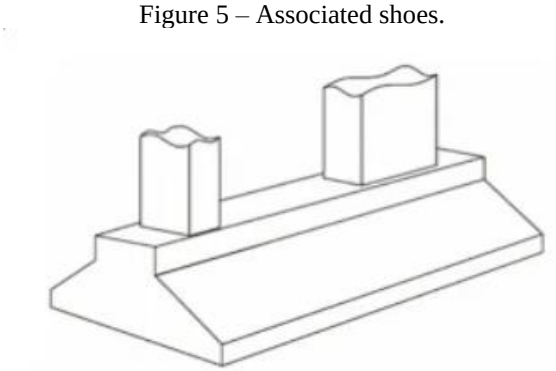
Source: Colégio Cetés (2013).

In addition to the conventional ones mentioned above, there are also the associated shoes (figure 5), which are used when, due to the proximity of the pillars, it is impossible to architect a unique shoe for each pillar. Therefore, a single shoe is used as the foundation for two or more pillars.

And there are also the running shoes, which are continuous elements that accompany the line of the walls, thus, the loads are being transmitted by the linear meter (BRITO, 1987). In the case of buildings in which the loads are not very large, such as residences, brick masonry is used (confusing with the

foundation, already mentioned above). Otherwise, or for projects greater than 1.0m, the use of reinforced concrete is more economical and feasible.

Figure 5 – Associated shoes.

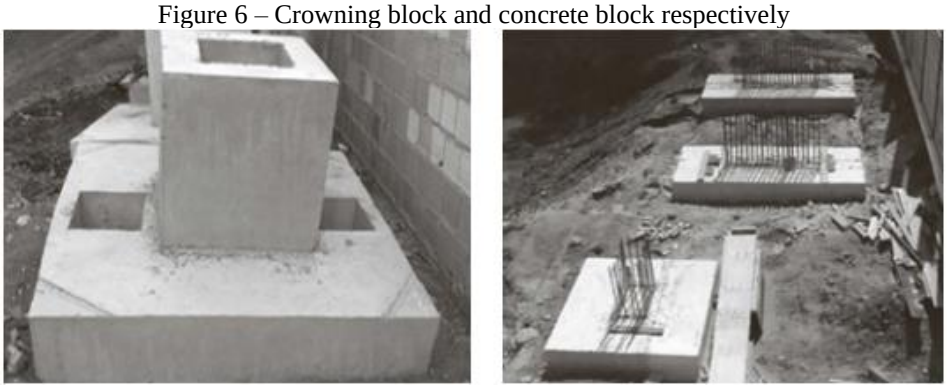


Source: Ferreira (2014).

Foundation blocks

They are also called support elements, however rigid and made of simple concrete and a relatively large reinforcement (figure 6), fundamental to combat compression.

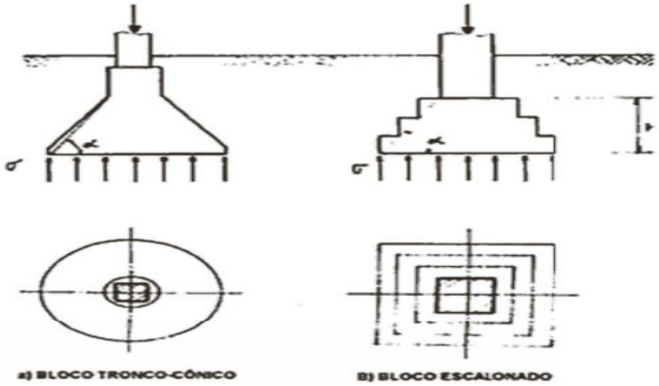
Figure 6 – Crowning block and concrete block respectively



Source: HFC (2017) and Tecnisa (2013).

Generally, these blocks adopt a staggered block, pedestal, or cone trunk format so that the volume of concrete used in their construction is reduced. (Figure 7).

Figure 7 – Trunk and staggered blocks



Source: Foundations – Diego Guimarães (2018).

Radier

It is a type of foundation similar to a plate, encompassing the entire construction area and having direct contact with the terrain. The raider aims to receive the loads transmitted by the walls and pillars of a building, transmitting them to the ground. They can be made of reinforced concrete, prestressed, or even reinforced concrete with steel fibers.

The raiders considered a resolution of high cost and high level of difficulty for execution in reclusive urban terrain. This type of foundation is chosen to be executed in small buildings since it is the most affordable indication. In the case of terrains with non-rigid soil, the radier is suitable, since more fragile soils require a firmer foundation layer for their loads to be uniformly distributed.

DEEP FOUNDATION

According to ABNT NBR 6122:2010, deep foundations are those in which the tip resistance (base), shaft resistance (lateral), or even the junction of the two is used so that the load coming from the superstructure is conducted to the foundation. According to the standard, in the case of deep foundations, the foundation depth must be greater than twice the smallest dimension in the plant of the foundation element. ABNT NBR 6122:2010 defines that the elements that fit as deep foundations are the following: piles, pipes, and coffins.

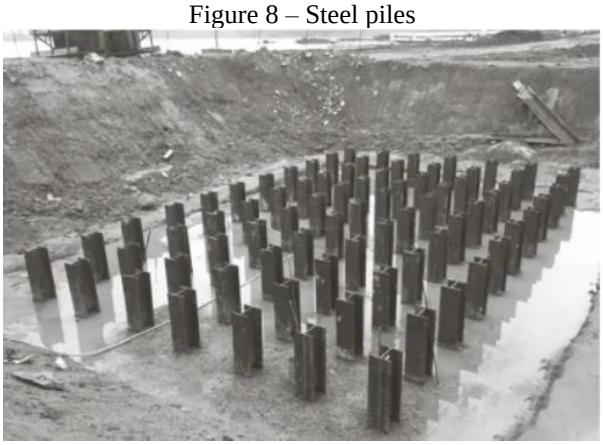
Stakes

Elements classified as deep foundations, with the support of a better team, are nailed to the ground. The piles can be of different materials such as wood, steel, and precast concrete, among other materials. (Figure 8)

The strategies are classified according to some criteria, they are:

- Effect generated on the ground: no displacement, little displacement, and a lot of displacement.
- Execution process: loco molded piles and precast piles.
- Operation: tip piles, friction piles, and mixed stakes.
- Carregamento: stakes of compression, traction, and flexion.

Figure 8 – Steel piles



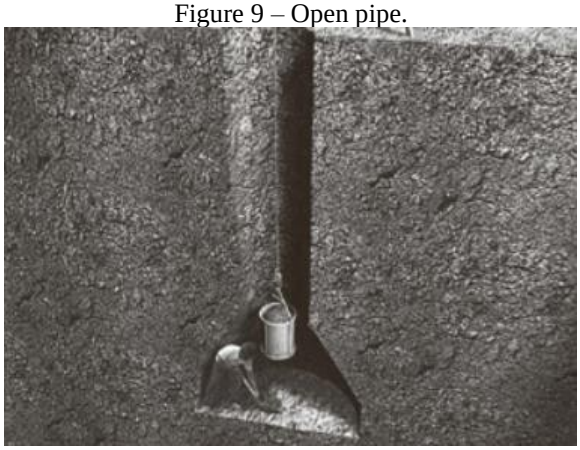
Source: Foundations – Diego Guimarães (2018).

Pipes

The pipes are also elements classified as a deep foundation, presenting a cylindrical shape (made of steel or concrete), and are executed from the concreting of an excavation, which may or may not be coated. In this case, there is a need for the descent of a worker in its final phase, divided into two basic types of pipes: open air and compressed air.

Open pit pipe: this is the concreting of an open pit, having its base expanded. The excavation can be performed manually or with the aid of equipment. The pipe is arranged above the water table, and in case of resistant and cohesive soils can be used below the water table; these limitations are essential to ensure that no collapse occurs. (Figure 9)

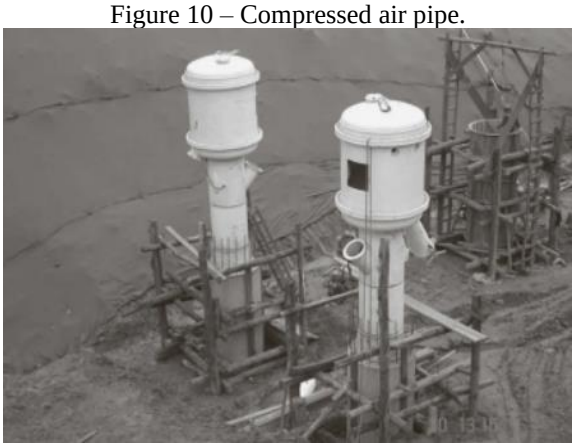
Figure 9 – Open pipe.



Source: Pereira (2015).

Compressed air pipe: it is a pipe, in which the presence of water, (on account of the water table), prevents its execution, requiring d the pressurization of the well for water suppression. Before the enlargement of the base, a delimitation is installed around the foundation. In this delimitation, compressed air is inserted in such a way as to make it impossible for water to enter the pipe. The employee will come down to work in the well under pressure, enlarging its base normally. The compressed air equipment is removed only after concreting. (Figure 10)

Figure 10 – Compressed air pipe.



Source: Roca (2017)

Coffins

They are resources used in deep foundations. Usually in the form of a prism, with concrete on the surface and installed by internal excavation. It may or may not have an expanded base and can be performed with or without compressed air. (Figure 11)

Figure 11 - Coffin

Source: Henriplan (2014)

3.2 PATHOLOGIES CAUSED TO FOUNDATIONS

In any construction, the foundation is one of the most important parts, especially when it comes to stability, to avoid ruptures and instability. One way to ensure greater safety as to the choice of the foundation, is by conducting sounding, in it will not be known of the subsoil and may result in an oversized or undersized foundation.

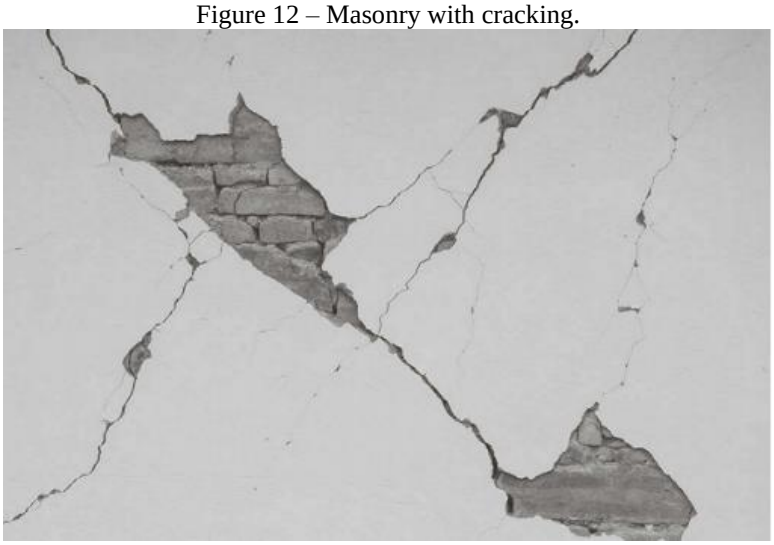
In the oversized foundation, the responsible will be using more steel and concrete, generating a greater and unnecessary expense, while in the undersized foundation, a foundation will be defined that does not support a load of construction, causing other pathologies to arise, such as cracks, repression, cracks and among others. Therefore, it is necessary a prior study of the soil, to provide safety, quality, and economy for the work.

Cracks

Seu emergence can hinder the aesthetics, safety, and durability of the structure (Figure 12). This occurs when the strength of the materials is not compatible with the requests. In addition, they can be classified into exogenous and endogenous.

- Exogenous: when they appear from natural factors, such as winds, floods, trepidations, excavations, and lowering of the water table, among others.
- Endogenous: as its name suggests, they are the cracks that arise inside, and are linked to the chemical reactions of the materials used.

Figure 12 – Masonry with cracking.



Source: Pathology of structures – Bianca Funk Weimer, Mauricio Thomas, and Fernanda Dresch (2018).

Repression

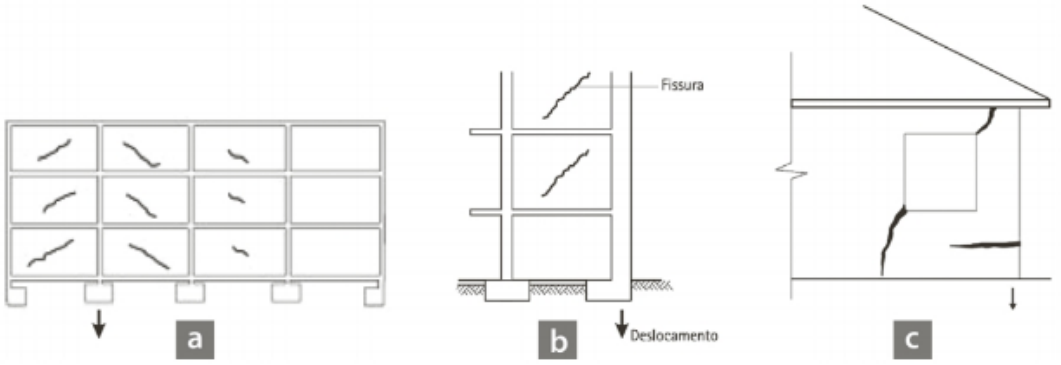
Vertical displacements are until the balance between the loads and the ground is established, which may lead to the appearance of cracks. In the schematic below (Figure 13)

a – Represents in the inner pillar

b – Represents the corner pillar

c- Represents the end of the supporting wall

Figure 13 – Cracking scheme caused by repression.

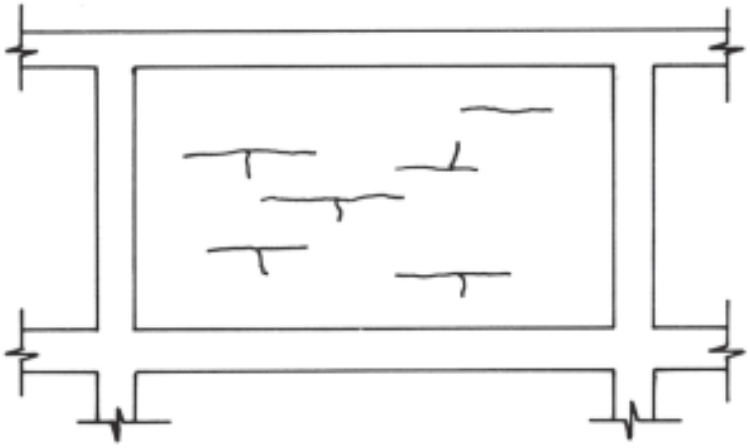


Source: Pathology of structures – Bianca Funk Weimer, Mauricio Thomas, and Fernanda Dresch (2018).

Broken

It is a variation of the cracks, that is, from 3mm, the crack becomes a crack (Figure 14).

Figure 14 – Horizontal cracks in the masonry.



Source: Cracks in buildings: causes, prevention, and recovery – Ercio Thomaz (2020)

4 CONCLUSION

It is concluded, therefore, that the realization of the soil sounding (collection of information such as soil type, layers, water table level, etc.) is essential for the choice of foundation to be made suitable for each type of soil, thus avoiding future problems in the construction in question. As already mentioned, the choice of a foundation and incompatible materials for a certain type of soil can cause several problems (often irreversible) to the construction.

The foundation is the base of any structure, however, since this base is not stable enough, the entire structure is compromised, which can cause very serious damage. Some examples of this are the appearance of cracks, which disfavors aesthetics and can often compromise the safety of the structure; repression of the structure to establish a balance between the loads submitted to the construction and the soil (which can also generate cracks); and the appearance of cracks, which are the result of these cracks mentioned above (cracks from 3mm are considered cracks).

Thus, it can be concluded that the survey has numerous long-term benefits. Many companies choose to neglect this service to reduce expenses but end up having infinitely greater problems in the future, having more work, losing more time, and spending more money. And it has already been seen that all these problems can and should be avoided through further study, which is the survey of the soil.

REFERENCES

ALBUQUERQUE, Paulo José Rocha D. Engenharia de Fundações. Editora LTC: Grupo GEN, 2020.

GUIMARÃES, Diego. Fundações. Porto Alegre: Grupo A, 2018.

MOREIRA, Carla Mesquita. Análise e proposta reforço de fundação devido às patologias apresentadas em um edifício residencial. Repositório Institucional, Universidade Federal de Uberlândia, p. (1-78), 2018

THOMAZ, Ercio Trincas em edifícios : causas, prevenção e recuperação / Ercio Thomaz. -- 2. ed. rev. e ampl. -- São Paulo: Oficina de Textos, 2020.

WEIMER, Bianca F.; THOMAS, Maurício; DRESCH, Fernanda. Patologia das estruturas. Universidade Federal do Rio Grande do Sul, Porto Alegre, 2004: Grupo A, 2018.