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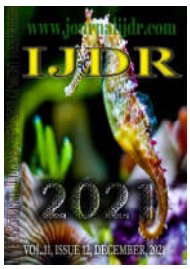

RESEARCH ARTICLE OPEN ACCESS

THE CAUSES OF COLLAPSE OF RETAINING STRUCTURES: A CASE STUDY OF A RETAINING WALL AT ALPHAVILLE IN NOVA LIMA MINAS GERAIS

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ABSTRACT

Retaining structures are designed to stabilize a soil mass, resisting earth and/or water thrusts, structural loads and any other stresses induced by adjacent structures or equipment. There are several types of containment that are designed for different needs and purposes, one of which is the retaining wall. The retaining wall is one of the most used containment methods in Brazil. These are concrete blocks that work together with steel bars, having different characteristics depending on your technical analysis, which can be by gravity or by bending. By better analyzing this structure, it is possible to assess its advantages and disadvantages, understand its execution process, and determine which type of work this structure is best designed for and what subsequent requirements are necessary to maintain the structure in perfect durability and avoid being cave-in. In this present research, it is intended to go deeper into the causes of the collapse of the retaining wall of a project that took place in Alphaville in the city of Nova Lima, in the state of Minas Gerais, Brazil, which can be observed as a lack of geotechnical knowledge they can cause structural and financial problems for enjoyers.

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INTRODUCTION

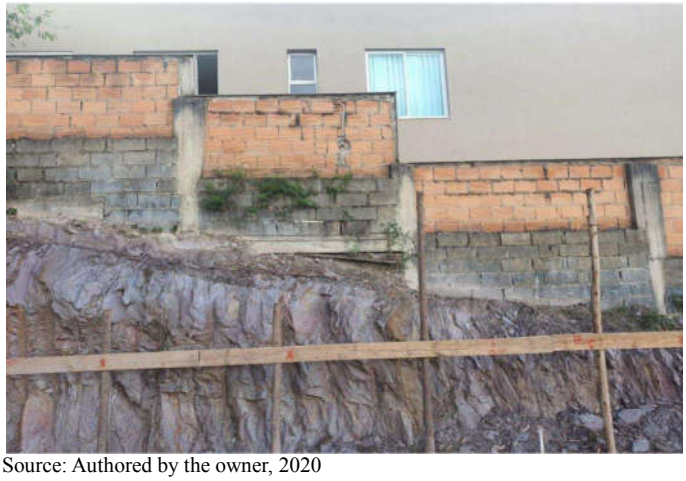
The retaining wall is a specific type of wall that has the purpose of supporting masses of earth, and isolating the land. It is a solution used on sloping and/or sloping terrain that will receive cuts to become flat. There are categories of retaining walls, those that work by gravity or bending. Those that perform their functions by gravity: are structures that resemble a right triangle, with a base wider than the top. The shape helps to contain the horizontal efforts caused by the soil mass and water. They are widely used to contain unevenness and small and medium cuts, with a height of less than 5 meters. They are made of stones, simple or reinforced concrete, gabions (metallic cages filled with stones) and even used tires. For LEITE (2011) the main characteristics of this type of structure are flexibility and permeability, therefore they accommodate to differential settlements and it is not necessary to use drainage systems. The bending retaining walls, on the other hand, are L-shaped, built in reinforced concrete, and may have heights greater than 5 meters, and as well as the gravity retaining walls, with a base wider than the top. According to Gomes and Lima (2018) "Bending walls are mostly composed of reinforced concrete, as they are under the influence of vertical loads, horizontal loads and moments". It is in general an expensive structure, and in some cases, due to excessive solicitation efforts, they need buttresses as additional structures, depending on the characteristics of the foundation soil, according to Domingues (1997).

For a retaining wall project, it is necessary to take into account two phases: The dimensions of the wall and the verification of stability to the acting forces. For this it is necessary that the designer or the calculator, through empirical formulas, determine the profiles (rectangular, trapezoidal, staggered), and carry out the lifting of self-weight loads, earth thrusts (active buoyancy, whose action of the soil mass on the retaining wall and passive buoyancy, which is the wall's reaction to the action of the soil mass) and soil reactions. These last ones, for their correct dimensioning, are extremely necessary to obtain the drilling report. Drilling is an indispensable element for any geotechnical work, and obtaining it greatly reduces the likelihood of future damage that a containment structure may cause. Some checks are necessary in the design phase for the stability of a retaining wall, such as: Verification or safety against tipping, slipping, rupture, global slope rupture and excessive settlement of the foundation ground. For each of these verifications there are theoretical and empirical formulas.

MATERIALS AND METHODS

With the heavy rainfall that occurred on Christmas Eve in 2020, several slopes and slopes were at imminent risk of ruin. Furthermore, with the lack of preliminary studies, problems can occur in containment structures, as was the case with the Retaining Wall

(Figure 1) in Condomínio Vargem das Flores in Alphaville in Nova Lima, which collapsed on the 25th 11/2020.



Source: Authored by the owner, 2020

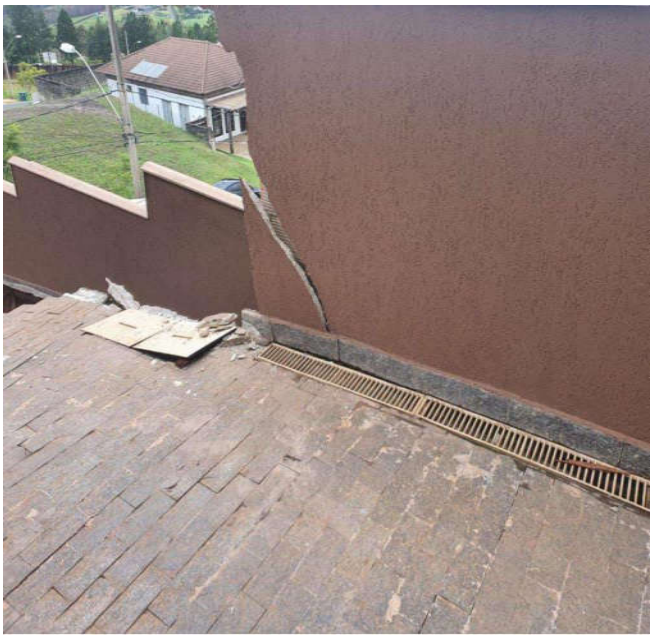
Figure 1. Retaining Wall

In this structure, part of the wall collapsed (Figure 2), due to lack of technical knowledge, and lack of respect for minimum spacing during the execution phase of the project next door, generating geotechnical problems that aggravated this containment.

Source: Authored by the owner, 2020.

Figure 2. Collapse of part of the retaining wall

It was observed through an inspection carried out at the site that, regardless of the rupture and displacement of the broken part of the structure, the wall remained intact, that is, there was a displacement towards the neighboring land, but without breakage and damage to the part displaced. According to information from the property owners, in part of the alignment of the right side border, a compacted landfill was made contained by a retaining wall, a fence made in concrete blocks with an approximate height of 1.50 meters, and pillars “L” shaped reinforced concrete with its base buried in the soil mass. A fence was made over this wall in ceramic block masonry with an approximate height of 1.30 meters. A concrete drainage channel was built throughout the alignment of the right side border, protected with a metal grid, in order to conduct rainwater from the property to the public network. In addition to this gutter, a gutter and a passage box were observed close to the boundary wall, which according to the engineer executing the work next door, that when it rains or when laundry is washed, water can be seen coming out of the base of the wall. This explains the cracks and fissures contained in the floor of the residence before the fall of the wall (Figure 3), which may have caused infiltration and made the wall more vulnerable.



Source: Authored by the owner, 2020

Figure 3. Cracks before the fall

RESULTS AND DISCUSSION

The retaining wall under study at Alphaville presented some technical problems of a geotechnical nature, in addition, of course, to problems arising from heavy rainfall at certain times of the year. The execution of the earthworks in section along the right side of the property, for the implementation of the construction works of the neighboring property, there was an imbalance of the earth mass and, as a consequence, the collapse of the land, the carrying of the compacted landfill and the displacement part of the boundary wall (Figure 4).

Source: Authored by the owner, 2020.

Figure 4. Displaced boundary wall

A fact observed in loco, culminating in the collapse, is that the sectional platform carried out in the work by the neighbor shows the significant cutting height of the land, far below the base line of the boundary wall of the owner's property above (Figure 5). The lack of drainage after the earthworks caused the mass of earth to percolate along with the water between the wall and the foundation. Since the soil is also of a silty character (as observed in loco), it presents a small water percolation, causing the water to remain "stored" in the earth mass for a longer period of time, which causes an increase in the active force on the wall. As a result, with the earthwork to the right of

the wall, the passive effort of the wall was reduced, causing the wall to be out of balance and more prone to collapse.

Source: Authored by the owner, 2020

Figure 5. Cutting height

CONCLUSION

Changes in the structures of terrain with original profiles on slopes in slope regions provoke a tendency of nature in search of balance, creating reaction forces in the sense of returning the terrain to its initial slope and stability.

Due to this natural characteristic of balance, the works of alteration of soil mass profiles (earthwork in cuts and embankments) must be carefully designed, supported by technical procedures and common sense, seeking to harmonize the interference of man with balance required by nature. Imperiously, the execution of this type of work must be monitored by the responsible technical engineer in all its phases (design and execution), ensuring compliance with the project or, in cases where the field is difficult, an adaptation that is in line with current technical standards and the constructive techniques. In conjunction with the earthworks, the solutions for containment of cuts and embankments must be preceded by projects prepared by duly qualified technicians and their execution also accompanied by a qualified professional.

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