Talud Stabilization of Bird House Residential in Manaus City

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Abstract

Slope stabilization techniques have been increasingly used in the field, mainly due to high market values for land in large urban centers. With this, the technical feasibility study guarantees the application of the best solution for each case. From this context, we sought to verify the best method of containment by means of a case study according to the parameters of soil resistance, cohesion and angle of friction at the residence Morada dos Pássaros in Manaus - AM. The methodology used was of an exploratory nature with a case study, where in the first phase the topographic survey of the study area was carried out. In the second phase, it was sought to plan the location of the holes, according to ABNT NBR 8036 (1983). for the accomplishment and technical follow-up of the investigation of the soil in the place by means of the test *of percussion to the percussion - SPT and in the 3º phase was characterized by means of physical and mechanical laboratory test with the collection of material. Considering the collected data, it is noticed that the soil is with 3% of plasticity, concluding that a soil with plasticity below 7% loses the capacity to be molded and to become brittle. Therefore, it is concluded that the best technique to be used is geosynthetics, both in cost and in soil absorption, due to the feasibility of redistribution of stresses and slope deformations.*

Keywords: Stabilization; Slope; Technical viability

1. Introduction

Slopes are called any sloping surface of the terrain that can often be subject to mass movement due to natural and / or human-induced phenomena or processes that contribute to landslides, infrastructure losses, human lives and others. indirect costs.

To this end, [1] defines slope stability as a high magnitude approach system for geotechnical applications. That in the case of slopes these analyzes are conditioned by the presence of minerals or permeable soils. These implications adopt the most accurate geotechnical design method with deeper soil testing.

However, choosing the most appropriate containment structure to be performed in a given situation is crucial to assess the characteristics of the local physical environment and to overcome perceived stabilizing situations on the slope, cut or landfill. [2] states that containment structures are indispensable elements of a wide variety of engineering works and projects, such as bridges, highways, and buildings in general, among others. Its function is basically to withstand a thrust of earth, giving safety to a slope and allowing the use of the space in front of it or its upper embankment.

Containment works require special care before being started, any excavation or cutting alters the equilibrium conditions of the massif and may destabilize it. Soil mass displacement is caused by erosion and gravitational movement, and to prevent or correct such situations, various slope stabilization techniques are available and it is necessary to choose the one that best suits the situation.

Thus, the general objective of the study is to verify the best method of containment through case study according to the parameters of soil resistance, cohesion and friction angle in the residential abode of birds in Manaus - AM. However, the study has as it is basic characteristic to leave as a criterion of choice and proposal for an intervention with low cost and timely stabilization of the slope, considering its degree of risk, technical knowledge, geology and anthropic action of the site.

2. THEORETICAL FOUNDATION

2.1 Containment Structures

Containment structures are primarily intended to contain massifs of soils requiring as much structural safety as possible in order to prevent and protect the structure and / or property and people [3].

It can also be said that a containment work is done by the introduction of passive inclusions in the massif to be stabilized. Such inclusions work essentially on traction and are combined with a face covering [4].

These structures must be sized to withstand the earth buoyancy and water pressures, so the important factors in choosing the type of containment are: type of soil to contain, geometry (height and space available for structure construction), presence groundwater, overload, foundation ground capacity and available material.

The use of the drainage system is essential to prevent water accumulation between the backfill and the wall, controlling water pressures and preventing increased thrust. The lack of surface drainage of the soil and the absence or inefficiency of surface drainage systems aggravate this situation [5].

2.2 Slope

Slope are designation that gives to any sloping surface soil or rock. It is composed of the following parts: foot, slope, top or crest and rupture surface [6].

The angle of a natural slope is the largest angle of inclination for a given soil type exposed to time, obtained without breaking the balance of the massif. According to [7], in non-cohesive (sand) soils, this angle practically coincides with the internal friction angle and, in clay soils, due to the high cohesion, can even be verticalized.

The slope contours are natural terrain formations and constitute almost all emerged land. According to the geology, pedology, geomorphology and climate of the region, the slopes can take different shapes and lengths, [8] characterizing them as convergent, planar and divergent.

[9] further characterizes that the slope can be considered as potentially unstable when shear stresses originating from stabilizing stresses are or may be greater than the shear strengths of the material available in a zone of the massif. define a potential rupture region.

2.3 Mass Movement

Brazil is considered very susceptible to mass movements due to climatic conditions marked by intense rainfall summers in regions of large mountain massifs. Movement evolution occurs slowly over time and quickly and significantly [10].

[11] classifies the movements into five types: falls, overturns, landslides, lateral expansions, and runs. For [12] the five mass movements are: creep, true slips, talus slip, rock block slip, avalanches or debris flow. In Brazil it is observed that the most common processes of mass movements are landslides that can be classified as landslides, falls or often creeping.

For this [13] classifies the causes of mass movements according to the functions of their position in relation to the slope or slope considering three categories: internal causes, external causes and intermediate causes.

In this sense [14] proposes that for the causes of these movements to be analyzed they should be observed through the slope stability that allows estimating how safe a slope is or will be and presents the safety factor equation.

2.4 Talud Stability

According to [15] ABNT NBR 11682 (2006) - Slope Stability has the purpose of assimilating the various actions that cause the collapse of the slopes, distinguishing the types of mass movements their causes and agents.

To this end, the current methods for slope stability analysis are based on equilibrium in a soil mass, taken as a rigid plastic body, on the verge of entering a slipping process [16]. Given the accepted methods for obtaining the safety factor are: Fellenius, Bishop, Simplified Bishop and Spencer.

The Fellenius method, stability analysis, has its safety factor underestimated and may err by up to 60% [17]. This method can generate security factors with gross errors, usually in favor of security.

Bishop's method considers the breaking surface to be circular in shape. It has as hypothesis the resultant of the forces between the horizontal slices where the shear strength has the presence of neutral pressure [18].

For both the Fellenius method and the Bishop method, it is assumed that the breaking line is a circumference and the soil mass is subdivided into slices or coverslips [19].

Spencer's method was developed for cases of circular ruptures, and then adapted to other rupture surfaces and uses the slice method. It is considered a rigorous method because it meets all equations of force and moment equilibrium, and it is necessary to do so by using iterative computer programs, such as Matlab or Fortran mathematical software [20].

2.5 Methods for Calculating Stability

The standard [15] ABNT NBR 11682/2006 deals with the stability of slopes including the conditions for study, design, execution, control and observation of stabilization works. This standard defines minimum safety factor values to be adopted in slope and slope projects, according to the degree of safety defined for the site of implementation of the work.

[21] mentions that, in order to analyze the stability of built slopes, they are performed based on the geometry of the problem, the inclusion of possible external loads, the knowledge of the geomechanical properties of the materials and the flow patterns.

According to [22], the most widely adopted methods for slope stability analysis are based on the principle of boundary equilibrium, that is, analytical. According to this principle, the stability analysis of a massif is performed by studying the equilibrium of an eventual portion of it, which detaches and slides over a given rupture surface.

Slice methods are practiced on functional problems, mainly because of their practicality to explore different soil layers with different characteristics, changes in the strength of the same layer, different neutral pressure configurations, various forms of rupture surfaces, etc.

Already the wedge method is the potential rupture space can consist of two or more planes. This occurs when there are layers or zones of lower resistance inside the massif proposing that the analysis be made considering that the potentially unstable soil mass is divided into two or more wedges [23].

3 METHODOLOGY

3.1 Location of Land

The land under study is located in the Residential Bird's House in Bairro Tarumã. The containment area has about 44,549.21 m², using only 3,300 m² for the project. Figure 1 shows the location of the study object in superior and lateral view.

Figure 1. Study object location in Google Earth and on-site

Figure 2 shows the slope with its extension from the slope crest to the foot.

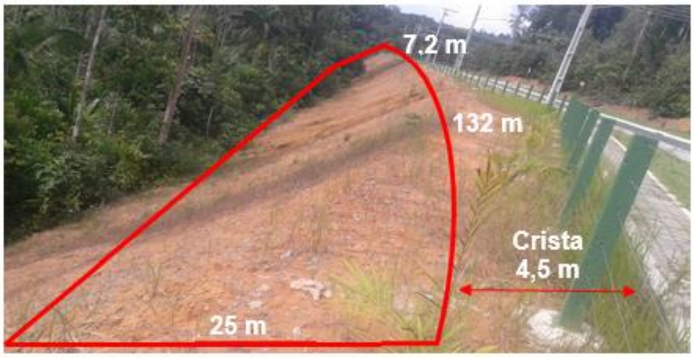


Figure 2. Measurements of the analyzed slope

3.2 Data Collection

For the first phase of data collection, a survey of the study area was performed using equipment such as: GPS signal receiver and Total Station that will be used to determine the geographical positioning of the points that form the perimeter of the terrain where the slope is inserted and a tape measure that was used to measure the distances between the points and the level difference between the terrain and the ridge crest.

In the second phase, the drilling plan was prepared according to [24] ABNT NBR 8036 (1983) - Simple Drilling Schedule for the realization and technical follow-up of the underground investigation through the SPT test for analysis of the report Probing.

The 3rd phase was characterized by field tests and physical and mechanical laboratory with the collection of material (terrain clay) in order to evaluate them to obtain physical and mechanical parameters of the material, such as granulometry tests according to [25] to ABNT NBR 7181 (1984) - Particle Size Analysis. Also carried out the liquidity limit test according to [26] ABNT NBR 6459 (2016) - Determination of liquidity limit and the Plasticity test according to [27] to ABNT NBR 7180 (2016) - Determination of liquidity limit. plasticity.

In the last phase, the results were analyzed to identify the best containment method and cost to be applied according to [28] ABNT NBR 8044 (1983) - Geotechnical design procedure.

4 RESULTS AND DISCUSSION

The slope under study has a maximum height of 25m with a 4.5m ridge of the hiking trail and bike path. Given this, the following will be presented the results and discussions of the survey, characterization of the terrain and soils.

4.1 Survey

Through technical monitoring carried out in loco, we obtained access to the topographic survey that covers the entire condominium surroundings and consequently the slope, including the boundary axes and buildings that could somehow influence the behavior of the slope. The elaborated project can be seen in Figure 3.

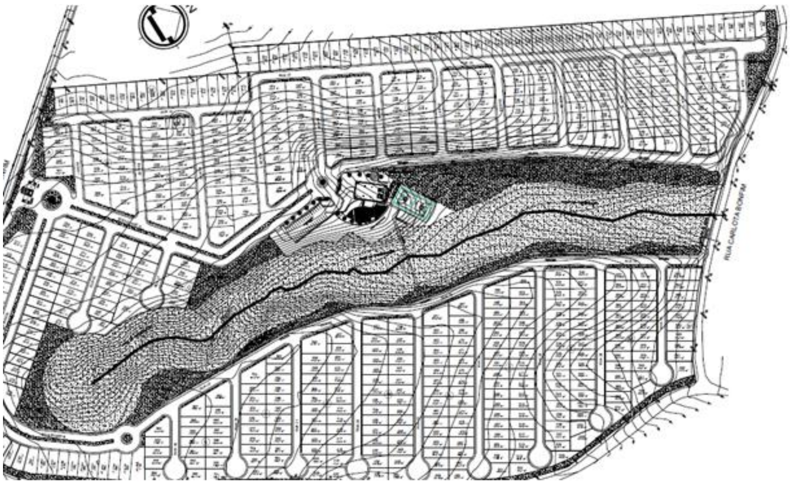


Figure 3. Altimetric Pre Project

In the soil rupture area, the area with the largest slip section was identified, where it traced its longitudinal profiles. It is observed in Figure 4 the section with stake 3 + 0.00 that it is possible to identify that the cut slope has an angle of 45º and that according to [15] to ABNT NBR 11682 (2006), the ground is of vegetal land. the right angulation.

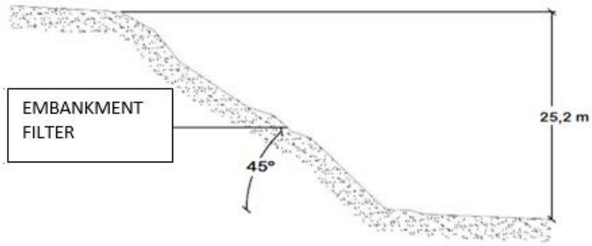


Figure 4. Cross Section

4.2 Terrain Characterization

The method used to obtain more information from the soil was the Standard Penetration Test (SPT), which according to [24] with ABNT NBR 8036 (1983), the simple recognition survey (SPT) was performed. by a planning of 3 holes for 3,300 m².

Through the survey profile conducted on site it was observed that there are no defined groundwater conditions. Therefore the condition of the surface portion is saturated, increasing the potential instability of the soil surface. On the soil surface profiled via SPT, silt clay was detected, and to obtain the void index, techniques were used by the determination test according to ABNT NBR 12004 (1990) - Determination of the maximum void index of soils.

According to the technical report it was verified the low resistance of the slope referring to the partially rigid silty clay soil. In which the appropriate level of soil resistance capacity is low.

The average permissible soil rate is 3.47 kg / cm² according to survey analysis, considering that the safety factor is 1.15 due to the area having a low level of movement and eventual permanence of people according to Then the soil shear stress is 24.27º, since it is a natural soil identified by the SPT test and distinguished by table 2 of [29].

Thus, it is possible to verify an expressive apparent cohesion of the soil, probably due to the existence of the phenomenon of soil suction, and of the same, when under natural moisture, a very high rigidity, losing part of this characteristic due to increased soil moisture.

4.3 Soil Characterization

In the granulometry test, the sample preparation method for the compaction test was used, which allowed the pre-drying of the sample to hygroscopic humidity, as defined by ABNT NBR 6457 (2016) - Soil Samples - Preparation For Compression. Where it consisted of drying the material collected about 1 kg in the greenhouse for a period of 24 hours at a temperature of 110 ° C, after that time removed the clods from the greenhouse, where the weighing was performed and realized a reduction of this material to 996.40 g. From this principle was used the set of sieves, allowing the separation of the different grain sizes of the aggregate. In Figure 5 one can observe.

Figure 5. (A) Soil weighing; (B). Soil in the greenhouse; (C and D) Screening test and separation of solids from soil separation

Given the performance of the coarse and fine screening test, a specific mass of 2.70 g / cm³ resulted from the test, where it was possible to generate the composition and the granulometric curve of the soil and thus make the composition and classification according to ABNT NBR 6501 (1995) - Rocha and Soils. Which can be observed in Table 1.

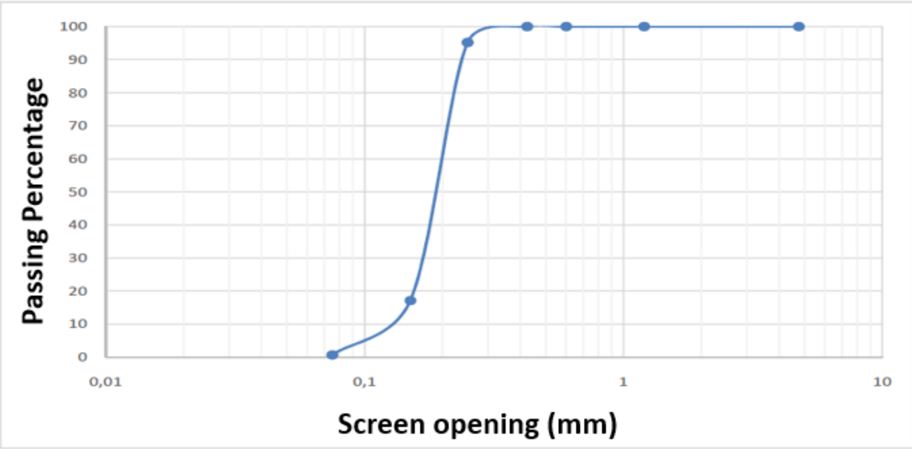
Table 1. Soil particle size composition

Fraction		Percentage
Boulder	(2 mm <∅≤ 60 mm)	0,3%
Sand	(0,06 mm <∅≤ 2 mm)	98,60%
Silt	002 mm <∅≤ 0,06 mm)	0,6%
Clay	(∅≤0,002 mm)	0,01%

Source: Own Authors (2019)

The particle size curve obtained in graph 1 shows the amount of each soil type that exists in the place where the material collection was used, being crucial to determine the slope stabilization type.

The granulometric test performed showed that most of the soil retained was in sieve # 100 and according to this result can generate the particle size curve.



Graph 1. Soil particle size curve

Source: Own Authors (2019)

The liquidity limit (LL) was determined according to ABNT NBR 6459 (2016) specification, being equivalent to the moisture content to which a slot in the ground is closed after 25 strokes in the standard apparatus, which can be observed in Figure 6.

Figure 6. Liquidity Limit Test (A) The Materials Used and (B) Test Performed

Given this number of strokes performed, it was identified, according to the numbering of each capsule, the weighing of wet and dry soil to identify the average moisture content, because according to the cycle, were repeated 4 times for different values. humidity until it reached the number of blows of the norm. Through these number of hits it was tabulated in:

Table 2. Liquidity Limit Test Result

Liquidity Limit				
Capsule #	18	19	20	21
Capsule with moist soil (g)	52,7	44,4	47,1	49,4
Capsule with dry soil (g)	50,3	42,1	44,7	46,5
Water mass (g)	2,2	1,9	2,3	2,9
Capsule Tare (g)	36,8	31,2	31,6	31,2
Dry soil mass (g)	13,5	10,9	13,1	15,3
Moisture content%	16,3	17,4	17,6	19,0
# Of strokes	37	28	25	22

Source: Own Authors (2019)

To perform the plasticity level measurement, 4 more capsules were collected with sieved soil from the 1st process, which followed the standard ABNT NBR 6457 (2016), which was broken and homogenized and thus separated for the execution of the tests. For each plasticity limit determination (LP) test, the following quantities were separated:

Table 3. Plasticity limit in soil sample

Plasticity Limit				
Capsule #	22	23	24	25
Capsule with moist soil (g)	30,8	30,7	35,3	34,8
Capsule with dry soil (g)	30,2	30,3	34,3	34,4
Water mass (g)	0,6	0,4	1,0	0,4
Capsule Tare (g)	26,8	26,1	29,4	31,2
Dry soil mass (g)	3,4	4,2	4,9	3,2
Moisture content%	17,6	9,5	20,4	12,5
			Liquidity Limit	18%
			Plasticity Limit	15%
			Plasticity Index	3%

Source: Own Authors (2019)

In view of this, about 10 g of the sample was taken and thus prepared to form with the fingers a small ball which was rolled onto the glass plate with sufficient pressure from the palm to form a cylinder and according to the dimensions. until the point of the ground reaches the plastic state.

Therefore, with the data found it was found that the soil has 3% plasticity, concluding that a soil with plasticity below 7% the soil moisture content changes from the plastic state to the semi-solid state, it loses its ability to be molded and becomes brittle.

The costs found for the execution of curtain containment for the 3.300m² area were R $ 73,446.66 and for the containment with grass was R $ 7,573.50.

5 CONCLUSION

The study of stabilization solutions for the chosen slope required a deep approach to consider the soil resistance parameters achieved in the tests, as well as the cost criteria of two (2) most common stabilization methods.

Based on the SPT test and the granulometry, liquidity limit and plasticity tests it can be observed that the soil of that region is silt clay, where its molding process for the test was difficult, because the porosity level and Soil plasticity has become the least compact material.

Due to the porosity factor and low plasticity of this soil, the basic budget of material and preliminary services that can influence beyond the physical-mechanical tests in the choice of the best technique to be applied on site was realized. For the containment of reinforced concrete pile curtains, the cost is now around R $ 73,446.66 compared to the bioengineering method that would apply only a blanket of fiber or grass and its cost would be R $ 30,294.00 Real.

However, in terms of quality, the technique used for curtains has a low level of rework, since it is more difficult to corrode the reinforcement and the execution allows to install drainage system. In this technique, as well as in stapled soil, it is possible to install a drainage system that conditions water out of the massif.

However, it is concluded that the best containment technique is the use of geosynthetics, because due to their versatility they can compose practically all the solutions addressed. Noteworthy is the use of blankets or grasses to cover the ground instead of concrete, given the differences in composition, cost and handling of materials ensures the efficient use of natural resources. Even if the national culture has a predominance of the "gray" work aspect (steel and concrete) prevails, there is a new vision and tendency of acceptance of the constructive market for alternative and innovative methods in Brazil, so that they do not fail in the final results.

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