Study of the Physical Aspects of Residential Soils of Iranduba - AM

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Abstract

The objective of this work is to study the physical indices of soil samples collected in different points of the municipality of Iranduba - Am. The parameters analyzed were moisture content, porosity, aeration degree, specific weight among others. For the physical characterization of the soil, samples with deformed structure were collected, prepared according to procedures described in the standard procedures described by the NBR 6457 standard (ABNT, 1986). The tests were performed using a high precision glass pycnometer. The tests resulted in samples with high voids and porosity, lower values of saturation degree as their low percentage. The specific grain weight presented satisfactory results meeting the criteria established by the standard.

Keywords: soil; physical aspects; Iranduba;

1. Introduction

Soil is arguably the most widely shared and abundant building material in the earth's crust. However, due to the high costs of civil engineering works, the use of soils as materials has been driven by more systematic technical specifications. The soil's physical environment assists in sustaining the passage of machines and resists tensile forces.

The significance of the soil is of prime importance. It is practical to understand the reason for different types of soils, but there are other causes for soil formation besides rock, and these causes are climate and weather, and over time, the size of the rocks decreases due to weather, that is, it promotes additions, losses,

transports and transformations of mineral and organic matter throughout its formation [1].

Currently, in the small municipality of Iranduba, many infrastructure works are being carried out, such as the widening of the highway that connects the city with the citizen of Manaus, capital of the state of Amazonas. For road and highway paving works to follow the necessary safety and reliability standards, knowing the types of soil are of paramount importance, after all, the different types of soil are determining factors for the foundations, structures and type of building. Be erected at a particular location.

Physical indices of soil present mathematical interactions between weights and volumes of elements of a soil mass, that is, between the parts of solids, liquids and gases [2].

Knowing the moisture content is essential and crucial in predicting the behavior of soils that will be used in various areas of construction, such as the construction of dams and earthworks for roads. The soil void index is directly related to the resistance of the soil, as well as its porosity defines the consistency and relation with the local humidity. The degree of saturation, the degree of aeration, the specific weight of the grains and the natural specific weight in the characterization of the soil are also extremely relevant characteristics for the success of a construction. In this sense, the objective of this work will be to characterize the soil of a region of the municipality of Iranduba from its physical indices, establishing the conditions in which the soil is at the time of its determinations.

2. Theoretical Reference

Soils are materials resulting from the decomposition of rocks by the action of chemical and physical agents. With the action of weathering the rocks are fragmented and disaggregated, originating the soil [3].

Soil texture corresponds to the proportion found across different particle sizes in a given soil mass [4]. Consistency is the intrinsic characteristic in aggregates, in sand, silt and clay particles, of staying together, making some soils harder and others softer [5] also ensures color as the most noticeable feature. Soil porosity becomes responsible for several phenomena and develops a series of mechanisms of importance in soil physics, such as air and water retention and flow, and if investigated, generates other physical properties associated with soil phase mass and volume. The importance of understanding soil physical behavior is linked to its correct use.

After a process of soil knowledge, to achieve satisfactory results it is necessary that the material goes through tests, aiming to analyze some physical indices. With this study, it is possible to determine the name of the soil. Given the above, and the little information on the physical indexes of soils of the municipality, the present work will present data of soils of the region.

2.1 Soil Types

As for their formation, we can classify the soils in three main groups: residual soils, sedimentary soils and organic soils.

Residual soils – are those that remain at the site of the source rock (parent rock), with a gradual transition from the surface to the rock. For residual soils to occur, the rate of rock decomposition must be greater than the rate of removal by external agents. Being the residual soils presented in horizons (layers) with decreasing degrees of weathering, the following layers can be identified: mature residual soil, saprolite and

altered rock [2].

Sedimentary or transported soils– are those that suffer the action of transport agents, which may be alluvial (when transported by water), wind (wind), colluvial (gravity) and glaciers (glaciers) [2].

Organic soils– derived from the decomposition and subsequent decay of organic matter, whether of a vegetable (plant, root) or animal nature. Organic soils are problematic for construction because they are very compressible. In some formations of organic soils there is an important concentration of leaves and stems in decomposition process, forming the peat (combustible organic matter) [2].

When observing the different types of soil it is necessary to know their particularities in order to better define the use of the land. It can be said that when a soil is suitable for construction, it must be unsuitable for agricultural purposes. So a very compact soil is convenient for civil works, but lousy for agriculture. Just as porous soil with lots of voids is good for agriculture but unsuitable for construction.

2.2 Physical Indexes of Soils

The soil is composed of solid particles that have voids between them. These voids may be filled with water and / or air. Thus we have 3 phases: solid phase - formed by solid particles; liquid phase - formed by water; gas phase - formed by air (vapor, gases) as we can see in figure 1.
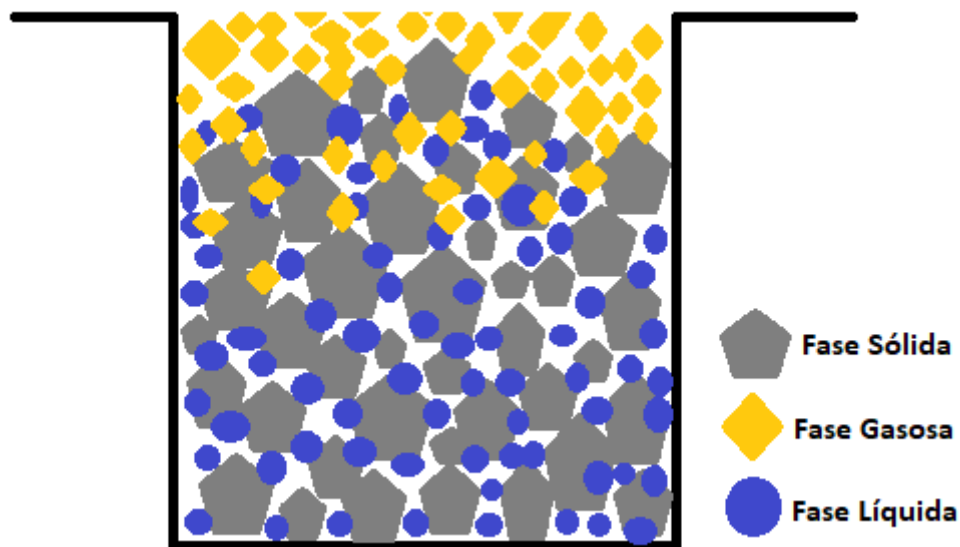

Figure 1. Scheme representative of the composition of a soil.

The behavior of a soil depends on the relative quantities of each of the constituent phases. We call physical indices the relationships between phases, characteristics that define the soil at a given moment. These are:

Moisture content(h) - It is the ratio, expressed as a percentage, between the weight of water (P_a) contained in a certain volume of soil and the weight of the solid part(P_S) in that volume.

$$h = \frac{P_a}{P_S} . 100 \quad \text{(Equation 1)}$$

Voids Index(ε) - It is the ratio of void volume(V_V) to solid particle volume(V_S).

$$\varepsilon = \frac{V_V}{V_S} \quad \text{(Equation 2)}$$

Porosity(η) - It is the ratio between void volume(V_V) and total volume(V_t).

$$\eta = \frac{V_V}{V_t} \qquad \text{(Equation 3)}$$

Degree of Saturation(G) - It is the percentage of water that fills the soil voids. The relationship between water volume (V_a) and void volume (V_V).

$$G = \frac{V_a}{V_V} \qquad \text{(Equation 4)}$$

Aeration Degree(A) - It is the percentage of air that fills the voids in the soil. The relationship between water volume(V_{ar}) and void volume (V_V).

$$A = \frac{V_{ar}}{V_V} \qquad \text{(Equation 5)}$$

Grain Specific Weight(γ_g)- It is the relationship between the weight of solid particles(P_S) and the volume of solid particles (V_S).

$$\gamma_g = \frac{P_S}{V_S} \qquad \text{(Equation 6)}$$

Natural Specific Weight(γ) - It is the ratio between total weight(Pt) and total volume(Vt). Humidity h is non-zero.

$$\gamma = \frac{P_T}{V_T} \qquad \text{(Equation 7)}$$

In nature there are no soils with moisture content of zero. This condition is only obtained in the laboratory, yet after a certain period of time, the sample will absorb moisture from the air.

3. Methodology

The samples were collected in the municipality of Iranduba - Am. (Geographic coordinates Latitude: 3°12'40"South and Longitude: 60°10'42" West). It has an approximate length of 2,900 meters on the bank of the Solimões River (figure 2) [6].
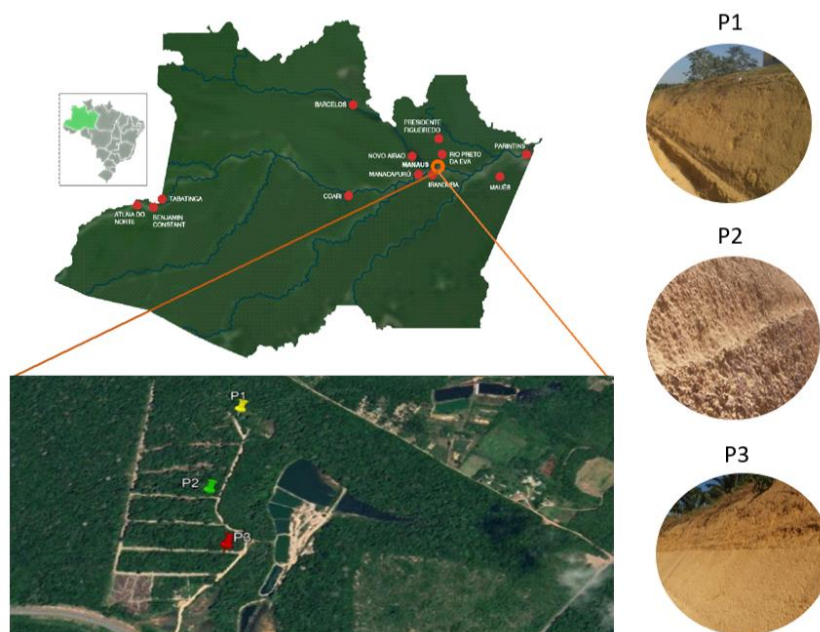

Figure 2- Location map of the sample collection points.

Source: [19]

The material was collected in three different areas, using the cuts of slopes from excavations on site resulting from the paving works being carried out in the area. Samples were collected with hoes and picks, stored in fully sealed plastic bags to prevent moisture loss from the material, identified and then sent for laboratory analysis. Samples were prepared following the procedures described by NBR 6457 (ABNT, 1986) [7].

Regarding the determination of the moisture content, the parameter used was the drying in the oven, also based on the standard procedures [7]. The kiln drying method can be used as a reference for calibration of other parameters, showing low cost of realization, requiring no exquisite equipment and or adding chemicals [8].

To determine the specific grain weight, the pycnometer method was used, following the procedures of NBR 6508 (ABNT, 1984) [9]. Initially the samples passed through the 2.0 mm aperture sieve, soon after, they were placed in the oven for drying, then each one was weighed. In order to avoid particle loss, distilled water was added to the pycnometer reference line. But before the material was added, it was weighed. Stirred to the outlet gas present, and again distilled water was added to the reference mark. Then, the set was weighed (Pycnometer + soil + water), shown in figure 3.

Figure 3. Set weighing.

4. Analysis and Discussion of Results

Three determinations of each sample were performed and the average of the measurements was considered as the final result for the analysis of the physical parameters. The values found are presented in Table 1.

Table 1- Sample moisture content.

Pattern	Soil (g)	Dry Soil (g)	Average Humidity (%)
P1	112,77	106,20	6,18
P2	34,05	32,04	6,9
P3	44,2	41,77	7,9

Source: Own Author

The results have moisture content higher than 6%, therefore, both show similar behavior when it comes to resistance. Differences between materials may occur when they dry out, this happens when the degree of saturation reaches a value of 80%, this is the presence of continuous air [10]. As the moisture content varies, the geotechnical parameters change (shear strength, deformability, conductivity) [11].

Table 2 shows the physical soil indexes for the collected soil samples, which are: natural specific weight (γnat), grain specific weight (γg), moisture content (h), void index (ε), degree of saturation (G), degree of aeration (A) and porosity (η).

Table 2- Physical indices of the soil.

Pattern	h (%)	η (%)	ε	G (%)	A (%)	γnat (g/cm³)	γg (g/cm³)
P1	6,18	44,65	0,81	20	80	1,53	2,61
P2	6,9	54,2	1,18	14	84	1,19	2,44
P3	7,9	68,92	2,21	9	91	0,87	2,6

Source: Own Author

Analyzing the results found in Table 2, it can be observed that the samples have high voids and relatively high porosities greater than 40%. The void index between 0.80-1.00 and porosity between 45-50% is called high, and above that very high [12]. Based on this, it is verified that the sample 1 is denominated with high porosity and voids index, while the samples 2 and 3 as very high. The degree of saturation between 0-25% of the soil is termed as naturally dry, and observing the three samples, both have a percentage below 25% [12]. Samples with high void indices and low degrees of saturation, seen in the literature, are lateritic tropical soils [13]. The results achieved for the specific weight are considered satisfactory as they did not exceed the considerable value by the standard.

5. Conclusion

The results provided a knowledge about the soils of the studied municipality, so that it was possible to characterize the region's soil from the soil physical indices. Based on the results it was possible to conclude that the values of saturation degree, porosity and void index presented higher results. These soils were analyzed with saturation degree between 9-20%, porosity between 44.65-68.92%. The void rates were around 0.81-2.21.For these soils it is natural to aggregate clay and silt particles, this is due to the presence of iron and aluminum oxides and hydroxides, thus presenting characteristics of mechanical and hydraulic behaviors. Based on these results, it is possible to conclude that the studied soil has resistance and deformation characteristics for the subsoil layers and can be better used as deep foundations in roads.

6. References

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