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Geotechnical research projects linked to paraguayan infrastructure development

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1. Introduction

Historically, the Paraguayan Chaco (Western Region of Paraguay) has presented less development than the Eastern Region of the country. However, its great extension, its strategic location and its economic potential, make this region a focus of interest from the economic point of view, so the infrastructure development of this region becomes very important for the country.

The Paraguayan road infrastructure has always encountered difficulties when trying to expand through the Chaco. This is due to the complexity of the soils in the region that offer low performance for road use, which makes the execution of any project studied for the area more expensive. For these reasons was conducted a study of dispersive clay soils of the "Bajo Chaco" Region and the improvement of its mechanical properties through chemical stabilization using lime as an additive.

2. Materials

2.1 Soil

The study area is located in the Department of Presidente Hayes (Paraguayan Chaco). Quiñonez Samaniego (2015) determined the existence of soils with dispersive behavior around the municipality of Villa Hayes.The result of the characterization of the physical properties of the soil is presented in Table 2.1.1.

2.2 Hydrated lime

The lime used during the work was a calcitic hydrated lime, produced in the city of Concepción - Paraguay. The test for the determination of the specific mass of the lime grains follows the recommendations of ASTM D854 obtaining an average value of 24.13kN/ m^3.

.2.3. Water

The water used for the molding of the test bodies was distilled water.

TABLE 2.1.1. PHYSICAL PROPERTIES OF THE SOIL

PROPERTIES	Value
LIQUID LIMIT	44,30 %
PLASTIC LIMIT	15,91 %
PLASTIC INDEX	28,39 %
DISPERSIVILITY	ND4
AASHTO CLASSIFICATION	A-7-(6)

3. Methodology

Controllable variables: Specific soil-lime weight: 17, 18 and 19 kN / m3; Lime percentage: 5, 8, and 11%; Curing time: 7 and 28 days; Curing temperature: 20 ± 2 ° C and 40 ± 2 ° C.

Constant factors: Type of soil: dispersive clay; Type of cementing agent: Hydrated lime; Molding temperature 21 ± 2 ° C; Moisture percentage (ω): 13% of mass of water divide the mass of dry material expressed as a percentage.

The response variables are those that result from the experiment: Dispersibility; Simple compression resistance; Loss of accumulated mass.

4. Results

The initial soil sample without addition of lime is classified as a soil of dispersive characteristics (ND4). With the addition of 1% of lime the response of the mixture to the test was improved, becoming "Non-dispersive" with 3% of lime.

From the values of the average simple compressive strength of the samples, it was possible to compare them in order to determine the reason for increasing the resistance of the soil samples influenced by the curing time.

The results reflect the impact of using higher curing temperatures achieved the simple compressive strength for the same curing time. The samples subjected to a curing temperature of 40 ° C experienced an increase in their resistance of 2 to 3 times with respect to their pairs subjected to a curing temperature of 20 ° C. Being the average increase of 2.58 times in the resistance of the test bodies subjected to a curing temperature of 40 ° C with respect to their pairs subjected to a curing temperature of 20 ° C.

5. Conclusions

With the addition of lime in 5%, the plasticity index drops from 28% to 9.5%, turning it into a soil with plasticity suitable for applications in paving.

From the dispersion point of view, the addition of lime in a dispersive soil(classification according to the cited test: moderately dispersive ND4) turns the soil to a non-dispersive classification (ND1) by adding 3% of lime in uncured samples.

Regarding to the mechanical behavior, the addition of lime increases in resistance for the three specific dry weights of the studied soil. In addition, it was observed that the increase of the curing time causes an increase in the simple compression strength of the stabilized soils studied. The samples subjected to curing with higher temperature, being 40 ° C for this research, obtained resistances two and three times higher than the resistance obtained when the curing temperature is 20 ° C).

With regard to the durability of the mixtures, the increase in the percentage of lime for soil-lime mixtures makes it possible to reduce the accumulated mass loss significantly. It was determined that the use of specific low weights resulting from standard compaction results in poor performance in case of using low percentages of lime for stabilization.

With regard to the durability of the mixtures, the increase in the percentage of lime for soil-lime mixtures makes possible to reduce the accumulated mass loss significantly. It was determined that the use of specific weights resulting from standard compaction results in a poor performance in case of using low percentages of lime for its stabilization, independently of the curing temperature. By increasing the specific weight of the sample, the loss of accumulated mass is decreased. It is defined that in 100% of the pairs of test bodies studied, those subjected to a curing temperature of 40 ° C had greater durability during the development of the test compared to those subjected to 20 ° C.

References

ASTM D2487. Standard classification of soils for engineering purposes. ASTM International, West Conshohocken, PA, 2017.

ASTM D5102-09. Standard Test Method for Unconfined Compressive Strength of Compacted Soil-Lime Mixtures, ASTM International, West Conshohocken, PA, 2009.

ASTM D559. Standard Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures. ASTM International, West Conshohocken, PA, v. 4, n. C, p. 1–8, 2011.

ASTM D698-12. Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort, ASTM International, PA, 2012.

ASTM D1557-12, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort, ASTM International, West Conshohocken, PA, 2012.

ASTM D4647, Standard Test Methods for Identification and Classification of Dispersive Clay Soils by the Pinhole Test, ASTM International, PA, 2013.

ASTM D854. Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer. ASTM International, West Conshohocken, PA, 2014.

ASTM D2974-14, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils, ASTM International, West Conshohocken, PA, 2014.

ASTM C1580-15, Standard Test Method for Water-Soluble Sulfate in Soil, ASTM International, West Conshohocken, PA, 2015.

CONSOLI, N. C., DALLA ROSA, A., CORTE, M. B., LOPES, L. S., JR, AND CONSOLI, B. S. “Porosity-cement ratio controlling strength of artificially cemented clays.” J. Mater. Civ. Eng., 2011.

CONSOLI, N. C., QUIÑÓNEZ SAMANIEGO, R. A. AND VILLALBA, N. M. K. Durability, strength, and stiffness of dispersive clay–lime blends. Journal of Materials in Civil Engineering, 2016.

QUIÑÓNEZ SAMANIEGO, R. A. Estabilização de um solo dispersivo com adição de cal - UFRGS, Porto Alegre, Abril 2015.