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Geotechnical Characterization in Metropolitan Area of Great Resistencia: Types of Soils

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Abstract

Geotechnical and geomorphological precedents on the field of study show that there would be an important correlation between geomechanical profiles of subsurface and its genesis. *In* order to verify the existence of its correlation, in 2006 a research project named "Geotechnical characterization in the metropolitan area of Great Resistencia-Chaco" was initiated, where this work is framed into. *The* general aim of the work is to analyze geomechanical properties of underground soils layers into the area of Great Resistencia (Chaco), trying to identify typical strata and determine if really exists a relationship with their genesis. *For* this, forty-two Standard Penetration Test (SPT) were selected and analyzed placed at different points of the study area. *Due* to soils in the zone of study are sedimentary origin, in a first stage a study was made on grain sized properties of them and thereafter the soil type was analyzed taking into consideration its classification. *As* conclusion of the work can say that the grain sized characteristics and the types of studied soils are related strongly to the depth to which they are, being able to delimit characteristic layers. Although zones of area of study with little density of soundings exist, the analyzed results show a clear tendency between the soils types and the depth in which they are.

1. Background

1.1. Introduction

This work presents partial results reached in the frame of Research Project named "Geotechnical characterization in the metropolitan area of Great Resistencia- Chaco", which is being developed in the Applied Geoscience Centre at the National North-East University (U.N.N.E.). It specially analyze feature of soils in underground layers which are of particular interest for construction engineering of low to media complexity.

1.2. Study Area

We define as "Great Resistencia" the urban area encompassed by cities of Resistencia, Barranqueras, Fontana and Puerto Vilelas and their influence zones. It is located in the South-East in Chaco Province, next to right bank of Paraná River.

1.3. Geology

According to Russo, A. et al (1979), is geologically located in the Chaco basin

Paranaense within the geological region called Chaco Pampeana plain. Its most characteristic morphological feature is the almost total absence of relief. It matches to a not very mobile part of the crust, within negative tendency, where in a geological past, sense sedimentary marine and continental series were accumulated. Even today sediments are deposited in variable quantities, mainly located from decay of mountain elevations located in the west, carried out to settlement places by rivers and winds. It might be considered as a broad piedmont forest or a great alluvial plain. Thickness of sedimentary sequence does not manifest itself as uniform through the whole area. Crystalline basement does not outcrop within Chaco-Parana Plain, although it does on mountain settlements surrounding it. According studies made by Fiscal Oil Field (Y.P.F.) by means of drillings, in the zone of Great Resistencia crystalline basement would be at a depth of 1000 and 2000 meters.

1.4. Geomorphology

According to a geomorphology classification proposed by Popolizio, E. (1985), the zone of study is within a unit called Llanura chaqueña (Chaco Plain). Geomorphology generated in the region is constituted by huge dejection cones formed by displacements and spillage of present Bermejo and Pilcomayo Rivers which conducted as macro-streams under drier and cold paleo climatic conditions than present ones. The area is characterized by presence of older diffluent and in part labyrinthine riverbeds, which present a hand fan that may be clearly observed in cartographic documents (Popolizio, E. 1986).

Present riverbeds run in valleys limited by lateral paleo spillages that elevate on plains, so that watersheds are on these spillages and run nearly parallel to these drains, ending to close plain sectors that convert themselves in closed riverbeds without clear runoff or difficult connection with river runoff. Eastwards embedded plains become more and more dominant into the landscape and sustain environment of glens and estuaries of great extension (Bosch, D. et al, 2013). Vegetal coverage is so conditioned by morphology, existing higher forests on spillages and savannas, grazing lands and grazing brushes in embedded plains. As a consequence of the very lower slopes, difficulties of integration and efficiency of nets, during years of great rainfalls, hollows flood totally outstanding out only paleo-spillages (Popolizio, E. 1985). These features are distinguished clearly on satellite images and air photos.

1.5. Recent Studies

Precedents in many researches made beforehand by the staff of Applied Geoscience Center (C.G.A.) and other researchers indicate that there exists and important correlation between morphology and the paleo morphology with geotechnical parameters (Aguirre, M. et al, 1998; Sotelo, R. et al, 2001). Due to a lack of a global study that would try to establish the correlations before mentioned and if possible set its spatial location, in 2005 the GCA began to develop a research Project named "Geotechnical Characterization of metropolitan area of Great Resistencia-Chaco", into which this work is framed.

2. Materials and Methods

General aim of present work is to analyze geotechnical properties of underground horizons of soil, trying to identify typical strata and determine if there exists a correlation with its origins. Many geo mechanical profiles from different drillings made by authors of this study in consultancy works were made. In private study, for this work forty-two (42) borehole probes using the Standard Penetration Tests (SPT) between 5 and 25 meters depth, placed on different points of study area, were selected. In fig. 1 location of analyzed sounding can be observed and identified as P01 to P42. From SPT the following soil properties for each depth meter: SPT number (NSPT), natural moist, grain size characteristics, physical indices and in cohesive soils, data from rapid scaled triaxial tests can be obtained (Wroth, C. 1984; Clayton, C. 1993; Schnaid, F. 2009). Besides, cartographic information on geomorphological and topographic studies on study area were analyzed, which by space reasons could not be included. Due to soils in study zone are sedimentary origin, in a first stage properties of grain size properties of them were analyzed, since this property is closely related with its formation. Afterwards, this was correlated with depth, trying to state a pattern of behavior.

3. Discussion of Results

One of the classifying methods of soils more broadly used in Civil Engineering is the Unified Soil Classification System (U.S.C.S.) and it is the one employed to classify soils in the SPT (Lambe, T. et al, 1979). This system divides soils into two great groups starting by percentage that passes (or is retained) in sieve N° 200. If percentage that passes is more than 50%, the soil is classified as "fine" and in this group are included silt and clay. Conversely, if percentage that passes is minor to 50 per cent, the soil is classifies as coarse an in this group are sand and gravel.

Consequently, a variation of soil percentage passing sieve N° 200 was analyzed, with a depth for each one of the 42 boreholes tested and being obtained graph presented in fig. 2.

Watching fig.2, we may state that:

a) Value dispersion is greater in upper strata and it lows a lot according the depth.

b) On surface there exists fine soils predominantly clays and silts and when advancing into depth there are sand soils with decreasing quantities of fine

c) Considering variation of dispersion of results with depth, the following strata may be identified:

- From 0,00 to 2.00 meters, it is characterized by predominance of fine soils (clay and silt) without sand soils, variation range of sieve 200 is 50 and 100%,

concentrating mainly between 90 and 100 %.

- From 3.00 a 5.00 meters, there is a great dispersion, range of variation for sieve 200 is between 0 and 100%, with concluding that there exists any predominance of value. This shows the great variety of types of soils, from clay to sand.
- From 6.00 to 9.00 meters, values decrease remarkably, range of variation of sieve 200 is between 0 and 85%, concentrating mainly between 0 and 30%. Predominant soils at these depths are the silt-sands and sand in the same proportion
- From 10.00 meters, values continue decreasing with depth, evidencing that soils are more and more sandy ones and have less content of fine. A middle limit may be outlined on 16 meters

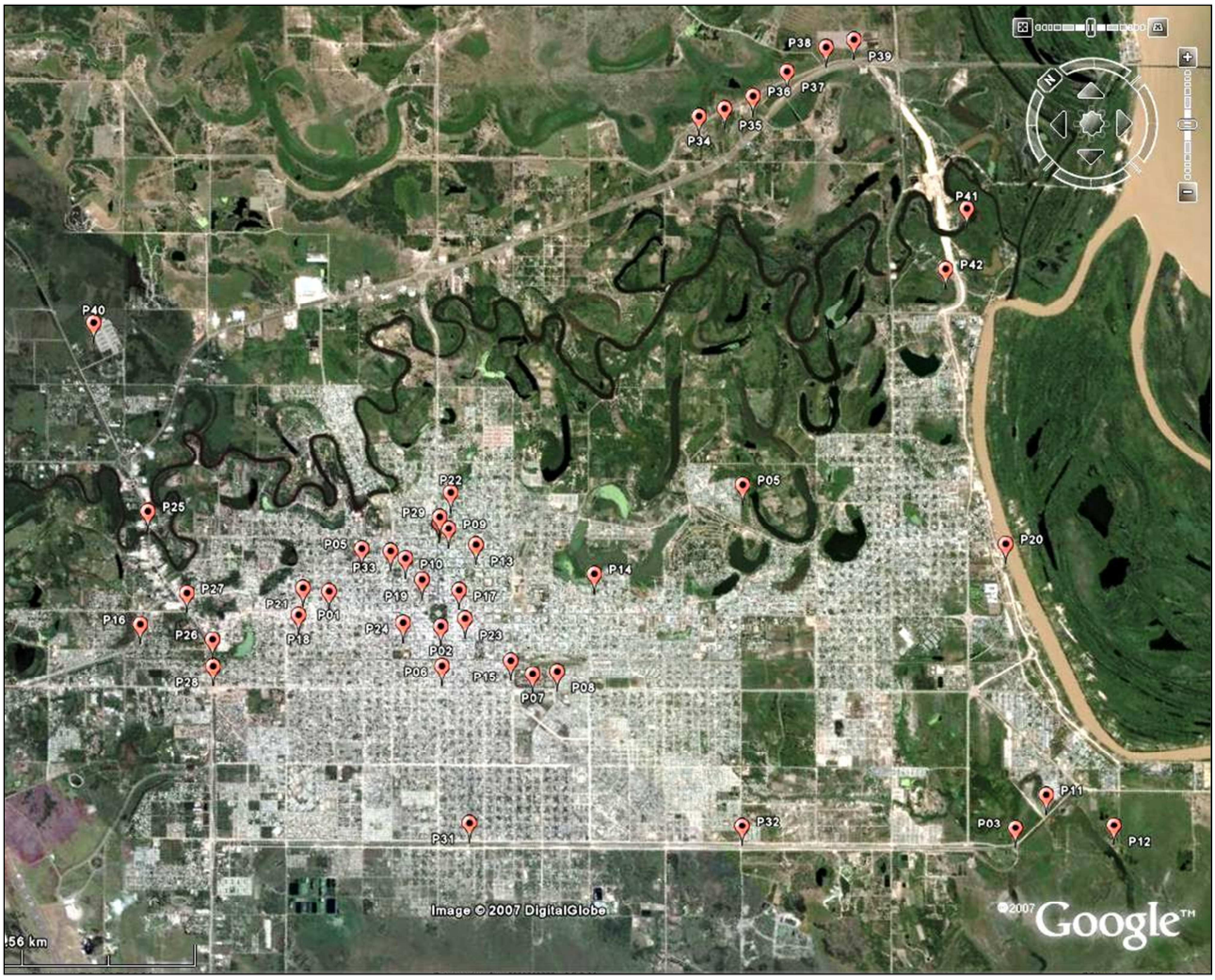

Figure Nº 1. *Location of boreholes analyzed within the study area (Google Earth image).*

With the intention of advancing in analysis, for each stratum above mentioned, the kind of soil according classification USCS was analyzed. Kinds of soils were re-grouped only into four types: clay, silt, silt-sand and sand. For each strata rate of these kinds of soils were calculated. The result of this analysis is presented in a graphic way in fig. 3, where rate of each type of soil in each strata was represented.

Watching fig.3, it may be concluded that:

a) Each type of soil has well distinctive rates according delimited strata.

b) Clays have marked presence on stratum from 1 to 2 meters with 80% of total probes of stratum, it decreases to 20% in the second stratum (from 3 to 5 meters) and practically it does not exist in the other strata.

c) Conversely, sands appear with greater predominance in deeper strata reaching 100% between 17 and 25 m.

d) Finally the USCS confirm the analyses made taking into account only value of percentage passing sieve 200:

- From 0.00 to 2.00 meters exists great predominance of clays (80%), followed by silt (11%).
- From 3.0 to 5.00 meters exists a similar rate of the four types of soils, that is, a great heterogeneity.
- From 6.00 to 9.00 meters prevails silt sands and sands with a little rate in silt.
- From 10.00 to 16.00 meters clays and silts do not exist practically, prevail sands over silt-sands..
- From 16.00 meters, neither clays nor silts were found

and there is a great predominance of sands with a little rate of silt-sand

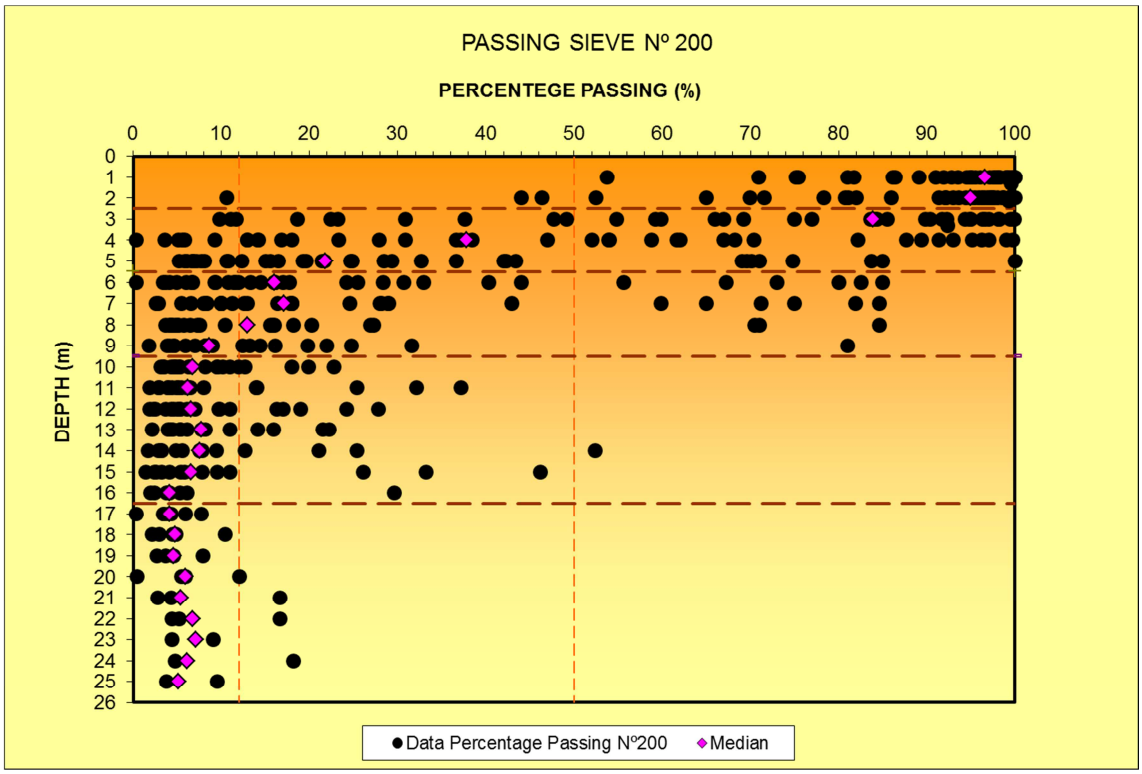

Figure Nº 2. *Variation of percentage of soil passing sieve 200 with depth.*

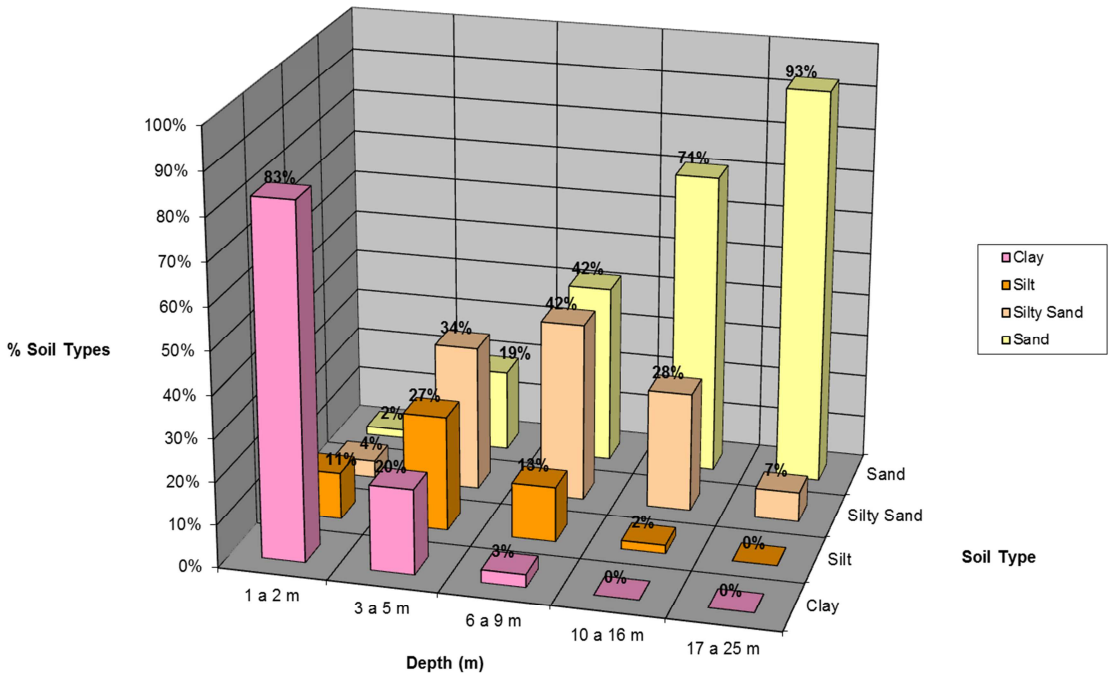

Figure Nº 3. *Percentage of soil type in each delimited stratum.*

4. Conclusions

Obtained results referred to the soils types of 507 probes on boreholes of SPT were analyzed from 5 to 25 meter depth made into the Metropolitan area of Great Resistencia, obtaining the following conclusions:

1) Grain size characteristics from soils are related with depth, existing mainly fine soils on surface and coarse in depth.

2) Strata well distinct may be delineate, each having proper predominance regarding the existence of different kinds of soils.

3) Although there is a zone in the study area with low density in boreholes, the analyzed results show a clear trend regarding the soils types and the related to depth where they are.

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