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THE FINE-GRAINED PLIO-PLEISTOCENE DEPOSITS IN ACHAIA – GREECE AND THEIR DISTINCTION IN CHARACTERISTIC GEOTECHNICAL UNITS

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Abstract

The fine grained Plio-Pleistocene sediments encountered along the Patras Ring Road project (PRR) were distinguished into two lithological units, the Upper Geotechnical and the Lower Geotechnical Unit, based on the detailed engineering geological – geotechnical mapping, at a scale of 1:5000, on fieldwork, as well as on data gained from the boreholes drilled during the design and construction of the project. These units are distinguishable, stratigraphically successive and present basic differences in lithological composition, consistency and permeability and therefore different mechanical behaviour during construction.

Key words: *Patras ring road, Pliopleistocene sediments, fine grained, Upper Geotechnical unit, Lower Geotechnical unit.*

1. Introduction

By taking into account site investigation data for Patras Ring Road (RPP) the findings from the construction of the project (Efpalinos Techniki, 1996, 1997, Edafomechaniki 1995, 1997 & 1998, Kastor, 1998, 1999, OMETE 1998 and Pangea, 1998, 1999 & 2001), other studies (Attewell, 1993, Rozos, 1989, Koukis & Rozos, 1990, Tsiambaos & Koukis1990, Koukis et al.,2005), and the results of our research, an inceptive suspicion was confirmed. This was that the fine-grained facies of the Pliopleistocene sediments, in which the project was mainly hospitalized, are formulated in two distinguishable and successive units: (a) the Upper Geotechnical unit and (b) the Lower Geotechnical unit (Kouki, 2006). An intermediate Transitional zone of small thickness can be separated at places, between these two units.

It is pointed out that the Lower unit is not easily recognized on the surface, since it is stratigrafically covered by the Upper one. Its presence was firstly acquainted during the excavation of the underground works, when its different geotechnical behavior was realized. Thus, it was mainly sought in deep gorges of the wider area, during the field work. It has to be mentioned here that the presence of these distinguishable geotechnical units was not evaluated during the geological - geotechnical investigations for the design of the PRR.

The field characteristics of these units are described in detail in the engineering geological - geotechnical map at a scale of 1:5000, that was compiled for the study area (Kouki, 2006, Kouki and Rozos, 2010), while in *Photos 1, 2 and 3*, their presence is documented.

Photo 1: Southern portal of tunnel SB (left branch). The two units (Upper and Lower ones) are distinguished, due to color and structure. Their continuity is interrupted by faults that considerably change dipping.

Photo 2: Northern portal of tunnel SA (left branch). The Pliopleistocene sediments are characterized by almost horizontal dipping. The Lower unit, grayish blue in color, is progressively changing, through the transitional zone, into the light gray Upper unit. In the centre of the Figure a normal fault is presented, that has substantially change the previous sequence and thus the slope (in the left hand site of the figure) is only occupied by sediments of the Upper unit.

Photo 3: Characteristic stratigraphic sequence of the fine-grained facies of Pliopleistocene sediments, with the grayish blue deeper horizons (Lower unit), that progressively is developing in the grayish brown transition zone and the light gray horizons of the Upper unit.

2. Evaluation of the data from the geotechnical study

Beyond the field work findings, further investigation regarding the segregation of the above units in the fine grained Pliopleistocene sediments, was also facilitated, by the data from boreholes drilled for the design of Patras Ring Road (Kastor, 1998, Edafomechaniki,1995,1997 & 1998, Pangea 1998, 1999). In every log of the 169 boreholes examined, there was an effort to group the various litho-facies that were recorded, in order to find out whether these distinguishable Upper and Lower units do exist in the wider study area or whether this is a unified formation with small differentiations. For that reason, the field observations and description of borehole logs, such as color, composition, cohesiveness, were basically examined along with in situ tests, such as SPT, and laboratory tests (i.e. grain size distribution and Atterberg limits). Characteristic logging of a geotechnical borehole is given in *Figure 1*.

3. The compilation of the geotechnical cross sections along the two branches of Patras ring road

For better understanding of the Upper and Lower units, the geotechnical cross sections for both branches (right and left) of Patras ring road were drawn (Figures 2 and 3). For the compilation of these, the topographic sections from the design of Patras Ring Road were used, supplemented with both the surface mapping, engineering geological and tectonic data, as well as those derived from borehole logs.

Thus, the segregation of the units was achieved with accuracy and the thickness was estimated ranging for the Upper unit from 2 to 37m, for the Transitional zone up to 8m, while the Lower unit has quite a significant thickness of over 60m.

Additionally, from the above sections it is shown that in the region of the Archaeological site of the area (Tunnel S1- Cut and Cover - Tunnel SG) and southwards, clayey marly horizons with coarse-grained materials of Pliopleistocene sediments were mapped, overlying the Upper unit, with a thickness fluctuating from 10 to 40m. Also, the Cut and Cover in Mpozaitika site, was opened in Dilluvial conglomerates.

Concerning the problems related to the Upper unit during construction, these are mainly due to the frequent alternation of beds with different lithological composition, such as brownish yellow to brownish gray clayey marls, sandy marls, sandy silts - sands, sandstones and conglomerates. The sandstones and conglomerates present differences in cohesiveness, fracturing and weathering, as well as in permeability. Thus, the sandy layers – sandstones are usually saturated and can create confined aquifers of small capacity, which can cause serious problems during the construction of technical works. Moreover, the formations of the Upper unit usually create thick weathering and fracturing zones, which lead to instability problems, especially in the case of tunnels with overburden of small thickness.

On the contrary, the Lower unit (usually stiff marls to clayey marls with thin coarse grained intercalations) is practically considered as impermeable and cohesive formation, which generally demonstrates uniform and very good geomechanical behaviour during the construction of underground works. It is pointed out that, this formation is distinguished for its dense bedding, which at places becomes foliar. This positively acts in conditions of regular moisture content (increased cohesion) and negatively when this formation is saturated, where the absorbed water in their structure leads progressively to collapse. This is mainly observed when the Lower unit formations are constantly watered in depth from overlying permeable layers of the Upper unit, as well as along structural discontinuities (faults and fractures).

4. Conclusions-Results

Based on the evaluation of all collected data, the following conclusions can be made:

- The discrimination of individual units was achieved in all borehole logs examined. Moreover, in some of the logs the limits between the units are not clear, due to the presence of an intermediate transitional zone of small thickness.
- The formations of Lower unit, as well as those of the transitional zone present high cohesiveness and characteristic bedding with frequent alternations of layers, which makes the discontinuities intersecting the formation visible. So, normal and reversed faults were observed due to tensile and compressive stresses on these sediments. On the contrary, these characteristics do not exist in the

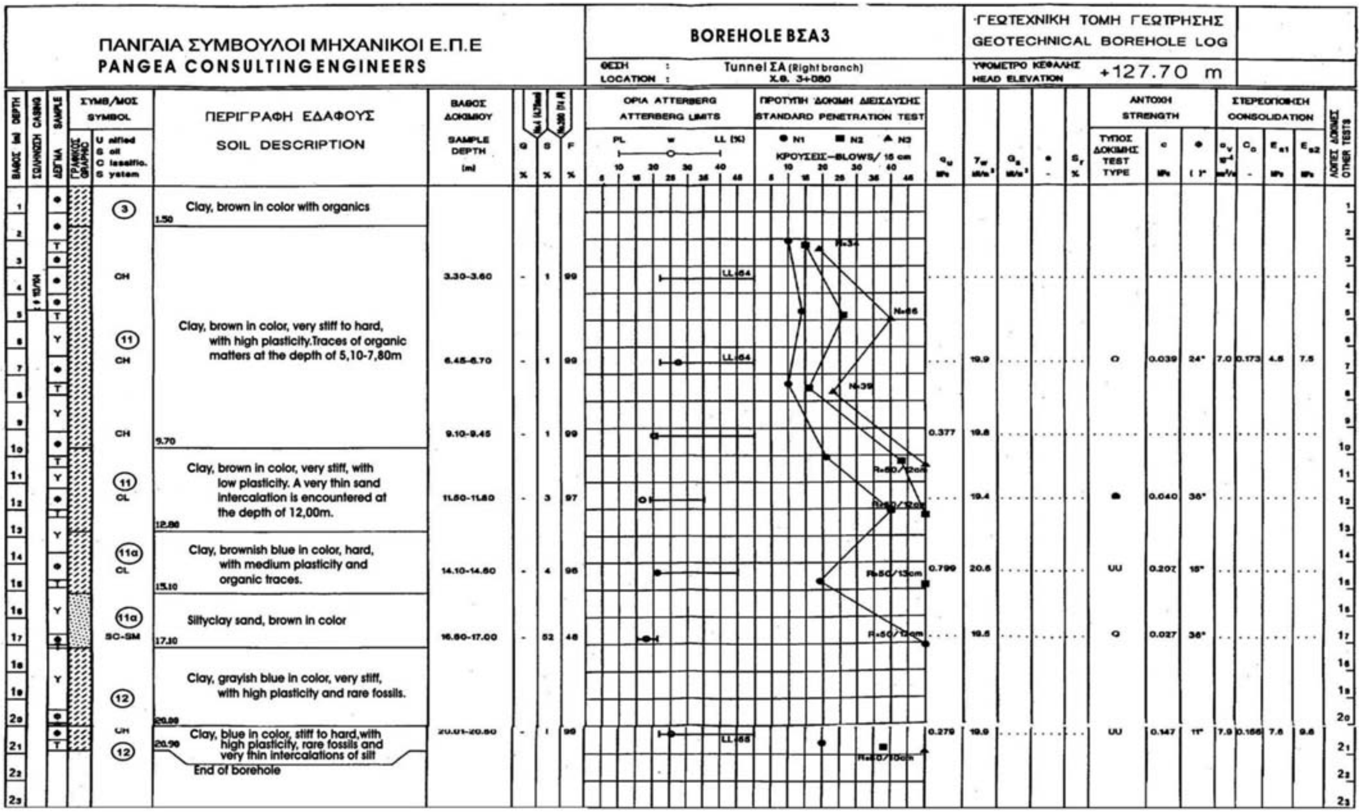

Fig. 1: Indicative record of a geotechnical borehole log, in which the geotechnical units, based on the relevant map, were separated.

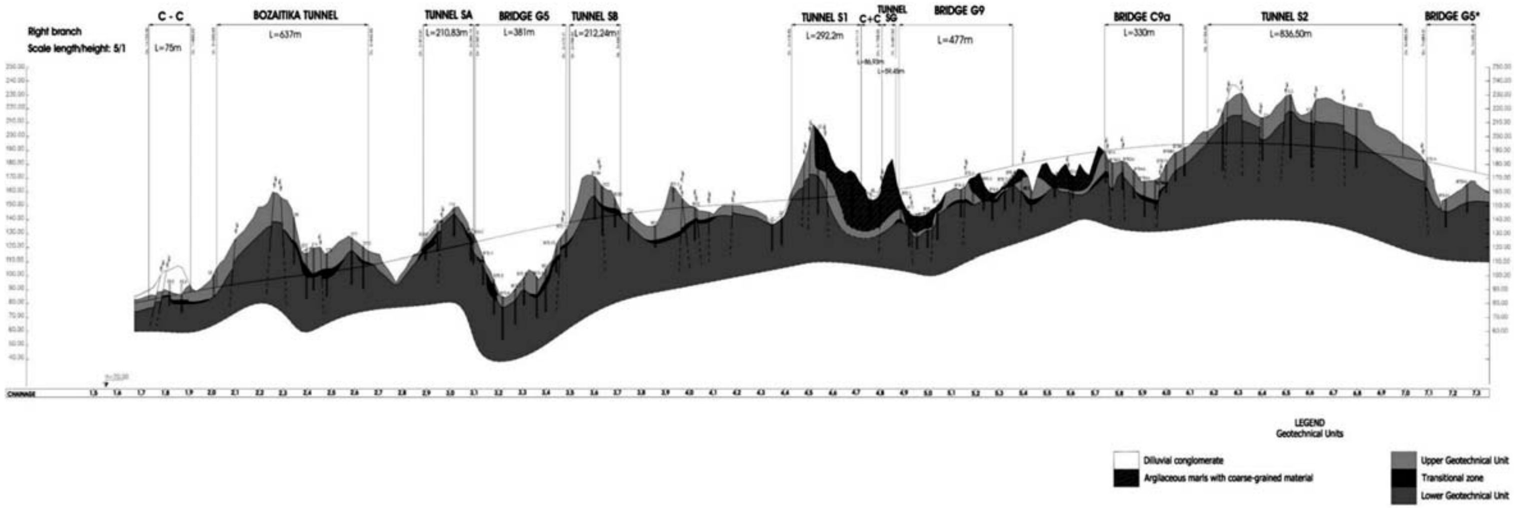

Fig. 2: Geotechnical cross section of the right branch of Patras Ring Road with the various underground works (Ch. 1+500 to Ch. 7+300).

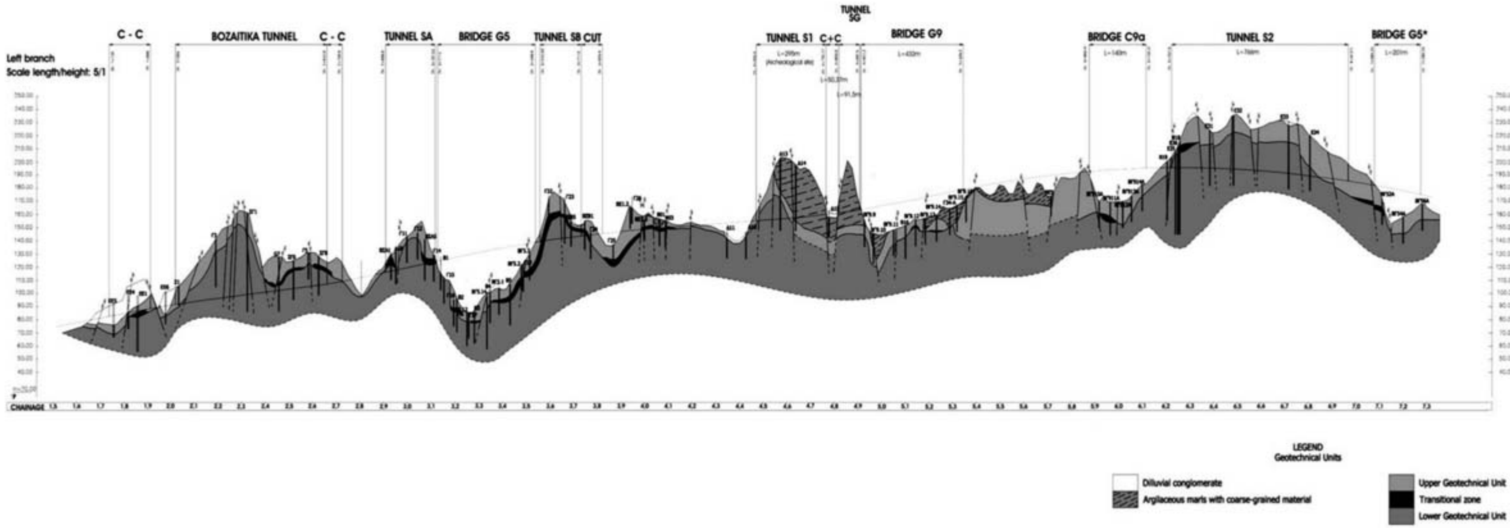

Fig. 3: Geotechnical cross section of the left branch of Patras Ring Road with the various underground works (Ch. 1+500 to Ch. 7+300).

Upper unit, due to its lithology and cohesiveness.

- There was an absolute match of the surface mapping observations with data from boreholes, which confirmed the presence and the segregation of the two units. Thus, this discrimination reflects both the surficial and the in-depth growth of the units, facilitating the confrontation of the geotechnical problems, which can arise during construction of technical works.

Based on all the above peculiarities, it is obvious that every further research for technical works under design should be focused on a detailed imprinting of these formations, both surficialy and in-depth. This will also enable the evaluation of their individual characteristics. With the confirmation and acceptance of this consideration and based on the fact that the Pliopleistocene sediments and in general the Neogene sediments in many regions of the Greek territory present an equivalent structure (in terms of lithology and stratigraphic sequence), it would be useful the geological and geotechnical research to be conducted towards this direction from the initial stages of the design. In this way the potential geotechnical problems will be pointed out at the early stage of the design, resulting to most optimal planning of technical works.

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