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E24 A REAL ESTATE FOUNDATION ON IMPROVED GROUND IN A RESIDENTIAL AREA IN BRAŞOV

BY

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Abstract. During the implementation of a project for a building in the city of Braşov it was found that the foundation soil has a much higher non-homogeneity than expected in the project. Therefore, for founding a homogeneous soil, at least in terms of mechanical behaviour, grouting with bentonite – cement suspension solution was adopted in a restricted area of the foundation soil. During verifications we have ensured that the resulting material has a similar behaviour with adjacent natural soil.

Key words: Foundation soil, grouting, bentonite – cement suspension, dynamic penetration

1. Introduction

This article is based on an office building project, accommodation / protocol, with height regime of 8 levels high and one withdrawn and a basement level, located in Braşov, on „Gării" Avenue, near the intersection with the street Harman. The area was free from other buildings. The structure will consist of reinforced concrete frames on the foundation slab type general. The roof is metal spatial structure.

2 Geotechnical data

2.1 Terrain stratification

The studied site belongs by geomorphological point of view to the alluvial plain of Brasov. The area falls within the alluvial deposits of the Piedmont city of Brasov. These deposits are the result of alteration, transport and deposition of material from the southern mountainous frame that defines the default Brasov and Brasov Piedmont

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The orogen is represented by the most internal units of the Carpathians bend area (Ciucaş, Piatra Mare, Postăvarul, Bucegi, and Piatra Craiului mountains). These units are situated in the Crystalline – Mesozoic zone and are formed of shales, Triassic, Jurassic (particularly carbonated) and Cretaceous deposits, calcareous and detritus. The forming of these massives was followed by the basin's sinking and it's fill material with Neozoic-aged lacustrian sediments. In the Quaternary, after the lake waters' receding from the Brasov region, the forming of piedmonts takes place: the Săcele piedmont, formed of the dejection cones of the Tărlung and Timiş rivers that have united, and the generator rivers were forced to deviate sideways towards lowest quotas; the Brasov's piedmont – formed of torrential waters and of smaller streams.

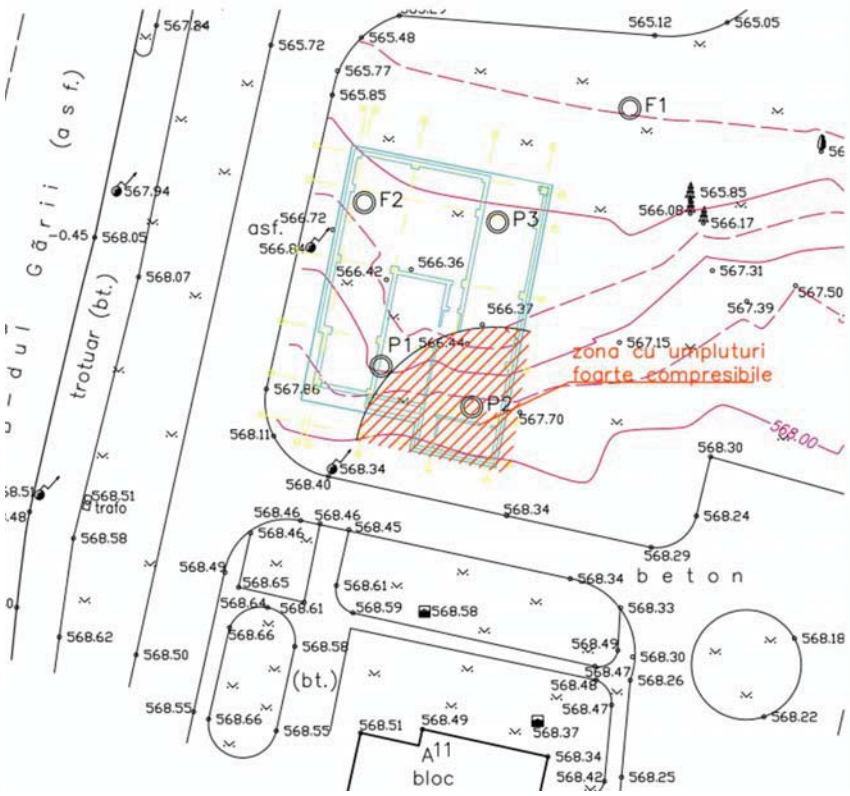


Fig. 1 – Site plan.

In lithological terms the bedrock is represented by non-cohesive materials, gravel sand of Quaternary age that dominates the entire depression of Brasov. Over it was formed by in situ alteration a silty elluvial blanket.

Sporadic was also found that there is a layer-sized filler witch has irregular thickness between 2.00 and 3.40 m. The fill material is the result of local exploitation of ballast (gravel with sand) during the execution of triage area constructions. Subsequently, these pits were filled in special loan with industrial waste (slag). In any case you can not

generalize in terms of homogeneity the fill material and therefore can not count on it as the foundation soil.

2.1 Field investigations

To identify the stratifications were studied drillings carried out in other work area (apartment buildings, the swimming pool). Two drillings were performed with continuous coring by 12 meters each. After starting execution, three more super heavy dynamic penetration were made.

Stratification which taking into account was originally composed of sandy gravel in which two layers of material inserted cohesive (sandy silt or brown silty-sand), these relatively uniform in thickness (1-90-2,30 m, ie 0.80 - 1.00) and in the surface a fill material layer with thickness from 2.00 to 3.40 m - see drill F1 and F2.

Drilling F1

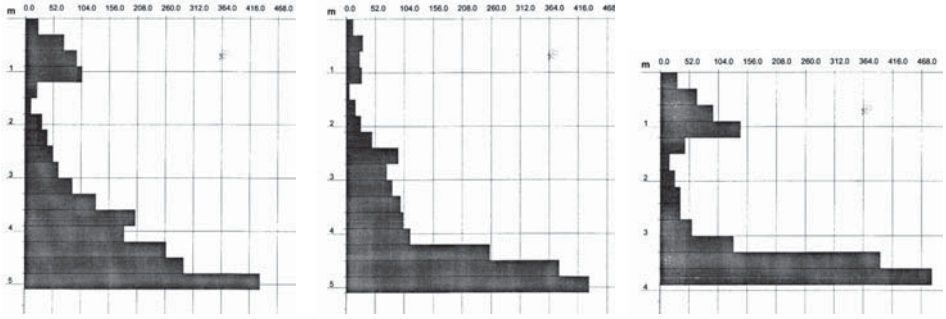
- On top fill with 2,00 m thick;
- 2,00-5,30 m silty sand with gravel, yellowish;.
- 5,30-8,50 m gravel with silty sand, brown;
- 8,50-9,50 m silty sand, brown
- 9,50-12,00 m gravel with silty sand, yellowish;

Drilling F2

- 0,00-3,40 fill
- 3,40-4,30 m silty sand with gravel, yellowish;.
- 4,30-5,20 m silty sand, brown
- 5,20-5,50 m silty sand with gravel, yellowish;
- 5,50-9,00 m gravel with silty sand, brown;
- 9,00-9,80 m silty sand, brown
- 9,50-12,00 m gravel with silty sand, yellowish;

The penetration P3 (on the northwest corner of the site) showed the following stratification from -4.70 m to quota

- 0,00 -1,90 m fill material (slag, gravel, sand, dust, etc.).
- 1,90 - 4,20 m silty sand, yellowish compressible
- 4,20-5,00 sandy gravel, yellow, stuff



a) b) c)

Fig. 2 – Depth - resistance to penetration charts:

a) penetration P1, b) penetration P2, c) P3 penetration

During execution of excavations, to the provided depth in the initial project for founding direct the general foundation, was observed on the northwest corner (about a quarter of the excavation area) there is a fill material affecting the homogeneity of the foundation soil.

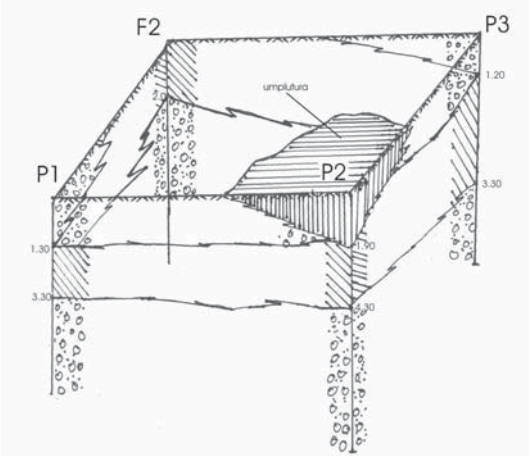


Fig. 3 – Block chart (at the quota of the foundation)

3. Analysis of foundation solutions

Thus, if initial was estimated a homogeneous absolute and a relative settlement that is within the accepted Norm NP 112-04 regarding the design of foundation structures directly, in the real situation estimated relative settlement approaches the value 0.002, which can not be accepted .

Consequently were discussed following the solution of the foundation:

- direct raft foundation on the improved ground in one of the following:
- The fill material in the northwest corner, with a thickness of approx. 1.90 m will be grouted to be brought to a linear deformation modulus E, approx. 20 MPa. Grouting will be covering the fill material area (see site plan) plus a width equal to the thickness of the material injected guard. The minimum depth of grouting will be a 2.50 m. Conventional pressure on foundation soil - sandy gravel and partially improved fill material - should achieve value P_{conv} = 300 kPa. The coefficient of sub-grade reaction has to be taken into consideration for the gravel layer, sand will be k_s = 40,000 KN/m^3 and for cohesive soil, silt, sand or brown silty sand, k_s = 20000 KN/m^3.
- Foundation on a ballast blanket (sandy gravel) with a thickness of approx. 2 m over the whole surface excavation after excavation fill material

(possibly only partial, depending on the requirements of construction) which will be compacted in layers elementary. We draw attention to two major difficulties that may arise in this version:

Plan dimensions of the blanket will exceed the raft edge with length equal to its thickness, that is 2 meters. Therefore, due to limited space the work will be extended to neighbouring buildings, which requires the consent of the owners, or slope will be supported temporarily by a method must be a separate project detail.

Acceptable pressure on the blanket must get anyway 300 kPa, a value well above those used in current practice. If verifying deformations by rigid plate on the first two basic layers will indicate that this pressure can be achieved only under onerous conditions, the material will be stabilized with cement around 4-8%. The blanket execution will be carried on a specification.

- Indirect foundations carriers drilled piles end-bearing piles.

This type of foundation was considered by the beneficiary as a last resort, considering it uneconomic but may be allowed at least theoretically. For predimensioning piles will take into account the value of bearing capacity 850 KN, for a isolated pilot of a 80 cm diameter and 1150 kN for a pilot diameter of 1.20 m in both length is 10 meters.

4. Conclusions

Finally grouting was made by STIZO society with bentonite – cement suspension mixture in the Eastern half of the site as the most adequate solution (sec. 1). Grouting was performed in nodes of a rectangular network of 1.50 meters long. Extending grouted area was considered necessary in view of low bearing capacity of the sandy silt on the one hand, and on the other hand it was considered that the whole site will be more homogenous. Grouting was performed to a depth of 2.50 meters.

Execution technology involves performing penetrations for introducing the cement. In this way we obtained additional data on dynamic penetration resistance of the original soil.

The checking after about 10 days after finishing the grouting it has been performed by heavy penetrations to check the results improve. Checks conclusions were satisfactory (see table 1 and fig. 4 from S.C. Stizo Fundaţii Speciale S.A.), given the fact that the time was relatively short and the mixture will improve their characteristics.

Table 1

Natural soil

Penetration no.	Depth Interva (m.)	Arithmetic average of strokes number
N1,N2, N3	0,40 – 1,00	91,333
N1,N2, N3	1,00 – 2,00	67,00
N1,N2, N3	2,00 – 3,00	42,00

Grouted soil

Penetration no.	Depth Interval (m.)	Arithmetic average of strokes number	
P1,P2,P3,P4,P5 ,P6, P7,P8,P9	0,40 – 1,00	55,333	
		91,333	55,333
		natural soil	grouted soil
P1,P2,P3,P4,P5 ,P6, P7,P8,P9	1,00 – 2,00	70,444	
		67,00	70,444
		natural soil	grouted soil
P1,P2,P3,P4,P5 ,P6, P7,P8,P9	2,00 – 3,00	66,555	
		42,00	66,555
		natural soil	grouted soil

As a safety measure was ordered that the settlement should be monitorised by surveying methods, both during implementation and during the first years of operation. By precaution, in the raft was left holes every 2 m^2 for further injections if the development will impose the settlements.

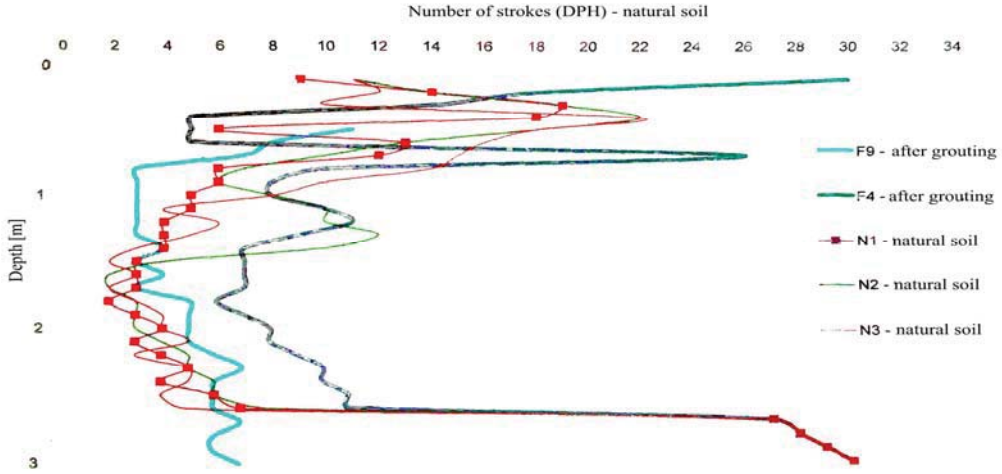


Fig.4-Comparison between penetrations made in natural ground and in the grouted site.

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