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COMPLEX STUDY OF THE SUBSURFACE AT A SMALL DEPTH USING GEORADIOLOCATION AND ULTRASOUND METHODS

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Abstract*. The subject of our research was to investigate, using georadiolocation and ultrasound methods, the influence of possible negative effects of plants on the foundation of a building located in the historical area of urban development. Georadar Zond 12e with its standard high-frequency 500 MHz shielded and 2 GHz high-frequency antennas was used in the research. Ultrasonic method is also an effective tool for determining the mechanical parameters of the environment and its mechanical structure. In the presented works, the ultrasonic equipment manufactured by the Swiss company PROCEQ, pulsed echo transmitter - Pundit PL-200PE was used. The presented research (study of underground layers) is not typical for the ultrasound method, although it was interesting to perform the work together with the geolocation method and to determine the possibility of complex investigation. The results obtained by radiolocation and ultrasound method do not contradict each other and there by increase the reliability of the conclusions.*

Introduction

In Tbilisi, near the central entrance of the Art Museum, there are two perennial Platanus trees, the influence of their root system on the nearest part of the foundation may be destructive.

TSU Institute of Geophysics conducted a small-scale geophysical survey with the complex use of georadiolocation and acoustic methods to clarify this issue. Georadiolocation method is intended to study the structure of underground layers at near-subsurface depths (0-50 m) [1-7]. The ultrasonic method is used to study the internal structure of various environments, to determine their elastic parameters, etc. [8-11].

Georadiolocation works

Georadiolocation works were performed on 14 georadiolocation (8 parallel and 6 vertical) profiles, while georadar Zond 12e with its standard high-frequency 500MHz shielded and 2GHz ultra-high-frequency antennas was used, georadar data was collected and processed with the standard computer software Prizm 2.7.

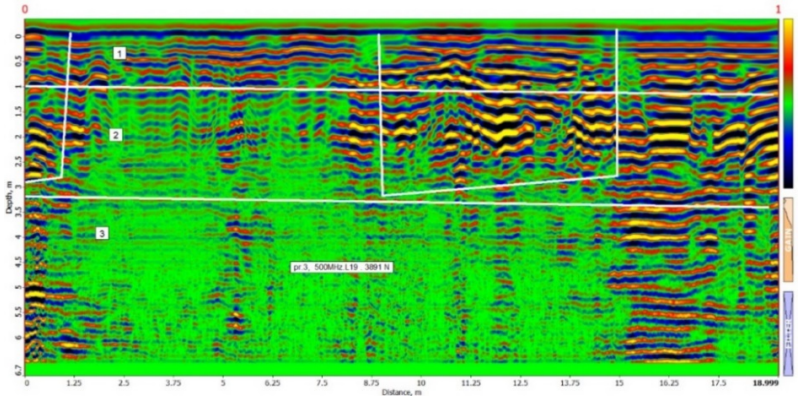

Fig. 1. The presented radargram runs parallel to the wall at a distance of 1.2m from it and is made with a 500 MHz antenna, on a 19m long profile of the GPR section, with a depth of 7m.

The task was to determine the possible root system of the Platanus tree in the near-subsurface location near the foundation of the building.

From the performed georadiolocation works, we bring, in our opinion, two parallel profiles along the foundation for 500 MHz and 2 GHz antennas, which determine the corresponding depths of penetration and the ability to distinguish covered objects.

Three geoelectric layers were identified on the georadar section presented in Fig. 1. Layers 1, 2 and 3 correspond to 7m power, separated according to the texture of the axes of sin-phase electromagnetic waves. Georadiolocation anomaly is marked at 9-15m distances, whose radio image corresponds to the heterogeneous area of the root system of the left, Platanus which extends from the daily surface to a depth of 3m. The influence of the right Platanus is slightly fixed at distances of 0-1.25m and with a depth of no more than 3m, its influence is practically absent in relation to the foundation. On the radargram, the radio image of part of georadiolocation anomalies and geoelectric layers are marked with white circles.

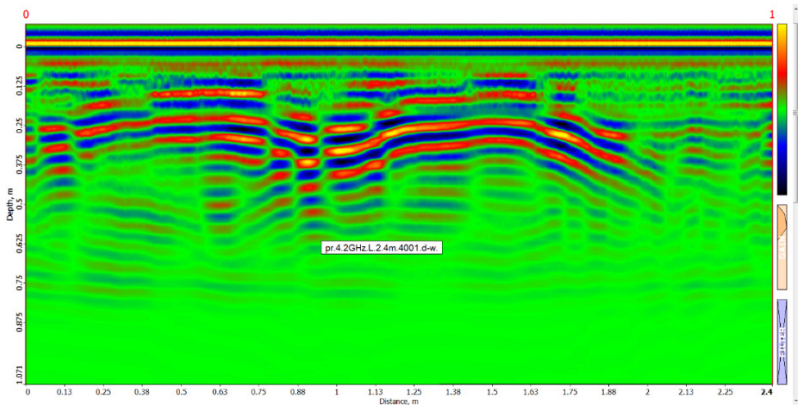

Fig. 2. Radargram for dry and moistened wood sample sections using 2MHz georadiolocation antenna, profile length 2.4m is presented.

Fig. 2 shows the cross-section of dry and wet wood for 5 cm thick samples from the radargram, less clearly for the dry and more clearly for the wetted sample. The location of the samples corresponds to their location recorded by radio sighting. A 5 cm cross section of a tree trunk sample used to simulate a 5 cm diameter tree root gives clearly defined radio image, which were not observed in the profiles taken along the building foundation. Thus, it can be said that the influence of roots in the immediate vicinity of the foundation is minimal and harmless to the structure in terms of underground damage.

Ultrasonic works

As proven in the world geophysical community, geophysical methods are used more and more often to solve various engineering and domestic tasks, to assess and investigate the condition of buildings and their infrastructure, and to carry out restoration works.

We used Pundit PL-200 and Pundit PL-200PE ultrasonic equipment to perform geophysical works.

Processing and visualization of wave and tomographic images obtained as a result of conducting ultrasound work was performed by means of "PL-Link" working program of Pundit - 200 and Pundit - 20PE.

In order to carry out the planned technical works, a work plan was drawn up, the purpose of which was to study the area surrounding the two tents in front of the main entrance of the art museum, in order to spread the roots of the tents in depth. We performed the work using the tomography (B-Scan) method.

We scanned three bands:

1. Near the wall at 69 points, with a range of 10 centimeters;

2. Parallel to the first strip, about 60 cm away from it, at 68 points, with a range of 10 cm;

3. Parallel to the first and second strip, 60 cm away from the second strip, parallel to them, at 69 points, with a range of 10 cm.

The penetration depth of the ultrasonic pulse into the medium depends on the density of the medium, voids, cracks and various inclusions in it and ranges from about 0.5 to 1 meter.

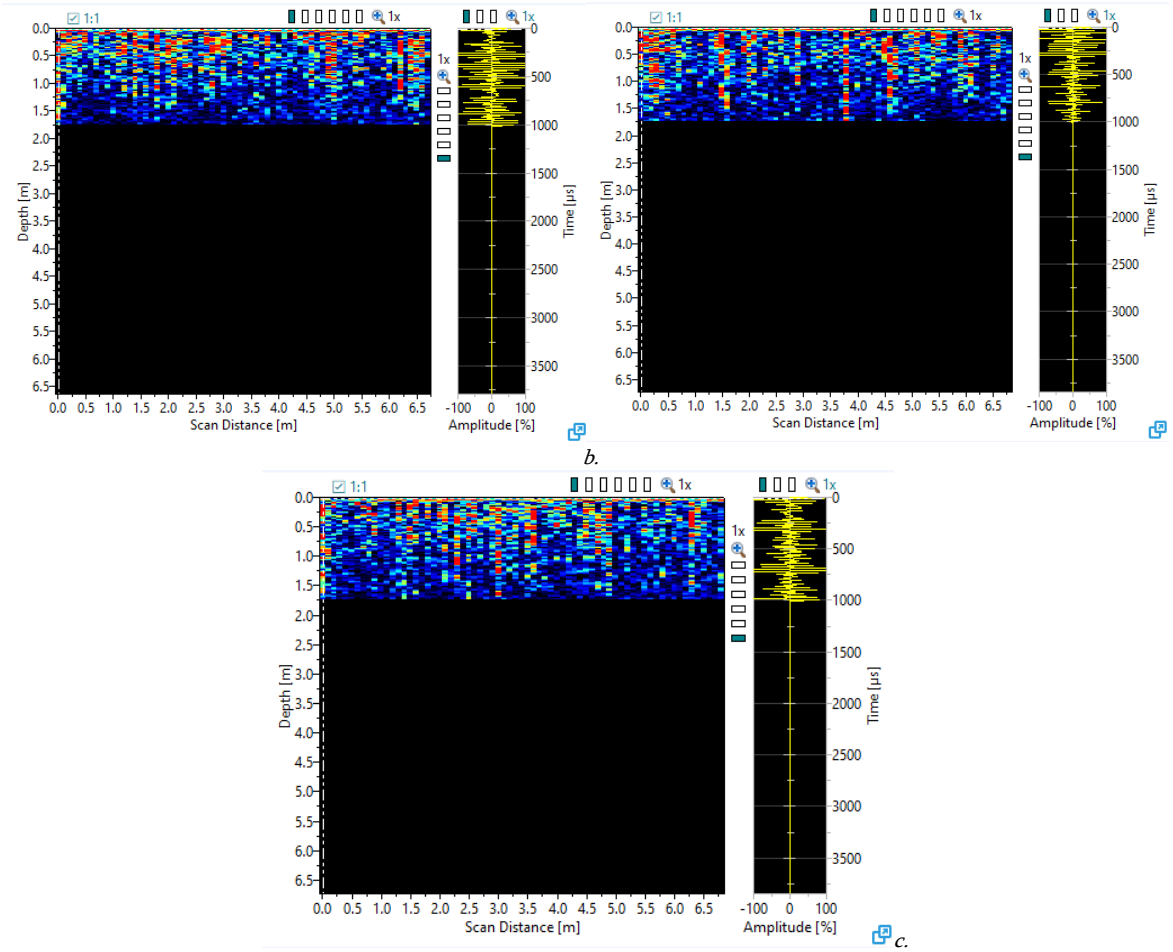

Fig. 3. B-Scan (tomogram) recordings obtained at (a) close to the wall of the art museum, with the maximum distance from the tree, (b) 60 cm from the wall, between the tree and the wall, and (c) 120 cm from the wall, as close as possible to the tree

In the presented tomograms, dark colored areas show weakened areas. fig. Comparative analysis of tomograms 3, 4, 5 shows some differences between them. However, it should be said that it is very difficult to identify weakened areas and connect them to the root system. Weakened areas may be related to various technical works carried out here. There is no such difference between the tomograms adjacent to the wall and the rest that we can uniquely connect it to the root system.

Conclusion

As a result of studying the influence of the root system of the Platanus trees located in the area near the central entrance of the National Art Museum of Georgia using georadiolocation and acoustic methods, it can be assumed that this influence on the foundation on the side of the facade of the building is minimal, since the presence of roots directly at the foundation of the facade is not fixed.

References

[1] Odilavadze D.T., Chelidze T.L. Geophysical modeling of the georadiolocation field in direct and inverse tasks of electrodynamics. // Geophysical Journal v.35, №4, 2013 pp. 154-160 (in Russian).

[2] Odilavadze D.T., Chelidze T.L. Physical modeling of lava tubes in the GPR. // Mikheil Nodia Institute of Geophisics, Transactions, vol. LXVII; ISSN 1512-1135, Publishing house of the Tbilisi State University, Tbilisi, 2017, pp. 129-142.

[3] Odilavadze D., Chelidze T., Ghlonti N., Kiria J., Tarkhnishvili A. Physical modelling of a layered wedge type model in direct and inverse tasks of georadiolocation. // Mikheil Nodia Institute of Geophisics, Transactions, vol. LXIX; ISSN 1512-1135, Publishing house of the Tbilisi State University, Tbilisi, 2018, pp. 44-61.

[4] Odilavadze D., Kiria J., Ghlonti N., Yavolovskaya O. The Results of Archaeogeoradiolocation Investigations of the Territory Inside the Rampart of St. Sophia Church of Khobi. // „Moambe" Bulletin of the Georgian National Academy of Sciences, v.14, n.4pp., 2020, pp. 51-56

[5] Odilavadze D., Tarkhan-Mouravi A., Varamashvili N., Arziani Z. Prevention of the Danger Triggered by an Earth quake of Exogenous and Endogenous Processes, using a Combination of Geophysical Geoelectric Methods In Geotechnics. // International Scientific Conference Natural Disasters in Georgia: Monitoring, Prevention, Mitigation, Tbilisi, 2019.

[6] Odilavadze D.T., Varamashvili N.D. Vertical electrical sounding and georadiolocation to assess groundwater level during orchard cultivation. // Journal of the Georgian Geophysical Society, 23(2), 2020.

[7] Varamashvili N., Odilavadze D., Kiria J., Ghlonti N., Tarkhan-Mouravi A., Amilakhvari D. Vertical Electrical Sounding and Georadiolocation to Assess Landslide Area Water Saturation. // International Scientific Conference „Natural Disasters in the 21st Century: Monitoring, Prevention, Mitigation" Proceedings, ISBN 978-9941-491-52-8, Tbilisi, Georgia, 2021.

[8] Varamashvili N., Chelidze T., Chelidze Z., Chikhladze V., Tefnadze D. Acoustic pulses detecting methods in granular media. // Journal of Georgian Geophysical Society, v. 16, 2013.

[9] Varamashvili N., Chelidze T., Chelidze Z., Gigiberia M., Ghlonti N. Acoustics in Geophysics and Geomechanics. // Journal of Georgian Geophysical Society, v. 21, 2019.

[10] Mohd Taufiq Mohd Khairi, Sallehuddin Ibrahim, Mohd Amri Md Yunus, Mahdi Faramarzi, Goh Pei Sean, Jaysuman Pusppanathan, Azwad Abid. Ultra sound computed tomography for material inspection: Principles, design and applications. // Measurement 146, 2019, pp. 490–523,

[11] Varamashvili N., Asanidze B., Jakhutashvili M. Ultrasonic Tomography and Pulse Velocity for Nondestructive Testing of Concrete Structures. // Journal of Georgian Geophysical Society, v. 23(2), 2020.