DOI: https://doi.org/10.5592/CO/1CroCEE.2021.75

IZIIS In Situ Geo Laboratory

Julijana Bojadjieva[1], Kemal Edip[2], Vlatko Sheshov[3], Irena Gjorgjeska[4], Toni Kitanovski[5], Dejan Ivanovski[6], Borce Veljanovski[7]

[1] *Associate Professor*, IZIIS, Ss. Cyril and Methodius University-Skopje, Macedonia, *jule@iziis.ukim.edu.mk*
[2] *Associate Professor*, IZIIS, Ss. Cyril and Methodius University-Skopje, Macedonia, *kemal@iziis.ukim.edu.mk*
[3] *Professor*, IZIIS, Ss. Cyril and Methodius University-Skopje, Macedonia, *vlatko@iziis.ukim.edu.mk*
[4] *PhD candidate*, IZIIS, Ss. Cyril and Methodius University-Skopje, Macedonia, *irena_gj@iziis.ukim.edu.mk*
[5] *PhD candidate*, IZIIS, Ss. Cyril and Methodius University-Skopje, Macedonia, *tonik@iziis.ukim.edu.mk*
[6] *Msc. student*, Ss. Cyril and Methodius University-Skopje, Macedonia, *ivanovski@iziis.ukim.edu.mk*
[7] *Msc. student*, IZIIS, Ss. Cyril and Methodius University-Skopje, Macedonia, *borche.veljanovski@geoing.mk*

Abstract

In order to study local site effect on the modification of strong ground motions and dynamic response of structural systems a three-dimensional strong motion instrumentation array at Ohrid Lake basin is developed in the 80's [1]. This 3D strong motion array is consisted of three free field sites with one surface and three downhole instruments each, up to 125 meters to the bedrock; one nine story building site with two instruments on the building, 4 instruments at the foundation level and one outcropping rock site with one instrument (location Tower).

Key words: geotechnical profile, in-situ investigations, seismic stations

In order to study local site effect on the modification of strong ground motions and dynamic response of structural systems a three-dimensional strong motion instrumentation array at Ohrid Lake basin is developed in the 80's [1]. This 3D strong motion array is consisted of three free field sites with one surface and three downhole instruments each, up to 125 meters to the bedrock; one nine story building site with two instruments on the building, 4 instruments at the foundation level and one outcropping rock site with one instrument (location Tower).

There is evidence of intense seismic activity along the proposed area for the study, as demonstrated by earthquakes with magnitude larger than six (M > 6) that have occurred throughout the history (1906, Ohrid, ML = 6.00; 1911, Ohrid, ML = 6.70). In 2016, an earthquake of Moment Magnitude of 5 according to the European MCS was felt in Ohrid. The epicenter was 12 km northeast of Ohrid. This earthquake caused visible damages especially to older and cultural heritage buildings and showed the gap between scientific observations and engineering practice. In Ohrid, previous research studies, such as [2] that have so far been performed in IZIIS have shown that geological conditions combined with a certain intensity of seismic exposure in some specific regions can exhibit geotechnical associated hazards which have unpourable effect on the building structures.

While an ongoing efforts are performed for reestablishing the 3D array for continuous and permanent real-time monitoring of the location, extensive framework for establishing In Situ Geo laboratory at one of the location (location Tower) is developed. CPT (Cone penetration tests), Standard Penetration tests and multiple geophysical measurements including seismic refraction tomography-SIRT, MASW (Multichannel analysis of surface waves), REMI (Refraction Microtremor Method), registration of microtremors (HVSR methods) are performed at the site for definition of the soil profile, strength, stiffness of the soil and shear wave velocity profile Vs. In order to validate usage and compare to different direct methods, GPR measurements with low frequency antenna are also performed on the same location.

Figure 1 represents the layout of the performed investigations while Figure 2 represents the performed investigations versus depth at the In situ Geo laboratory. The extensive in situ investigations will be used for the following objectives:

- Literature review of existing relationships to define the classification of the soil profile, unit weight of the soil layers, undrained shear strength, friction angle etc.
- Definition of Vs profile from geophysical investigations and possibility to make a corelation from CPT data to predict the Vs profil for the Ohrid region such as in [3].
- Investigate SPT-CPT, SPT-Vs corelations such as in [4, 5].
- Investigate liquefaction potential with CPT, SPT, Vs [6] methods for the specific location and provide conclusions for the wider Ohrid region.
- Investigate relationships for the definition of small strain modulus G_{max}, obtained from the field and from laboratory cyclic triaxial and simple shear tests.
- Investigate the GPR measurements to define soil stratigraphy in complex geologic conditions

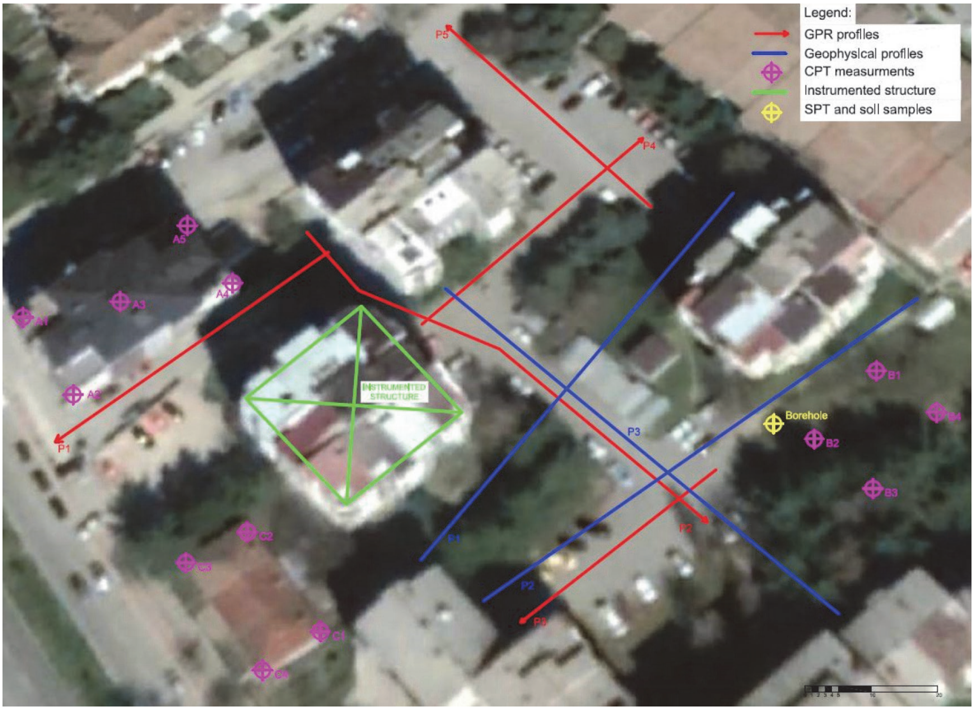

Figure 1. Layout of the performed investigations near instrumented building - Location Tower

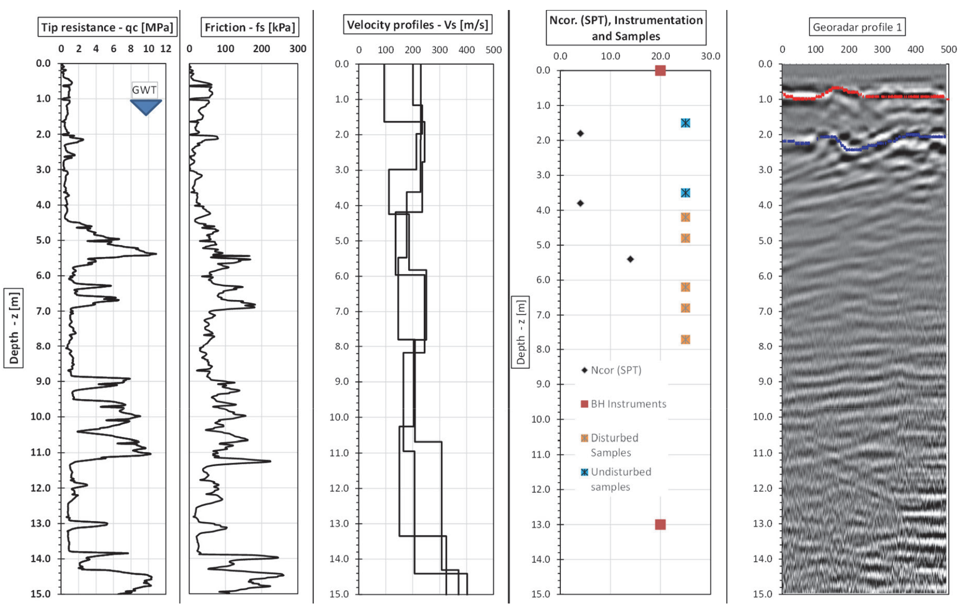

Figure 2. Extensive in-situ performed investigations versus depth at the In-Situ Geo Laboratory

The IZIIS In Situ geo laboratory is believed to be a proper case study with valid data to explore differences and correlation between different methods (direct and indirect). The obtained results and characterization of the geotechnical profile are beneficial for further studies for site effects (amplification and liquefaction studies) and soil structure interaction (SSI) when the 3D instrumentation array will be fully digitized and be able to perform recordings in real – time.

Acknowledgements

The presented research is performed in the frames of IZIIS internal research project 2020-2021, the provided funds and opportunities by IZIIS are deeply acknowledged.

References

[1] Petrovski, J. et al. (1995). Characteristics of earthquake ground motions obtained on the Ohrid lake three dimensional strong motion array in the Republic of Macedonia.10th European Conference on Earthquake Engineering, Duma (ed.) © 1995 Balkema, Rotterdam, ISBN 90 5410 528 3.

[2] Bojadjieva, J., Sheshov, V., Edip, K., Chaneva, J., Kitanovski, T., Ivanovski, D. (2019). "GIS based assessment of liquefaction potential for selected earthquake scenario". Earthquake geotechnical engineering for protection and development of environment and constructions. Proceedings of the 7th International Conference of earthquake geotechnical engineering. 7th ICEGE, Rome, Italy, 17-20, June, 2019.

[3] McGann, C.R., Bradley, B.A., Taylor, M.L., Wotherspoon, L.M., Cubrinovski, M. (2015). Development of an empirical correlation for predicting shear wave velocity of Christchurch soils from cone penetration test data. Soil Dynamics and Earthquake Engineering, 75, 66-75.

[4] Robertson, P.K., Campanella, R.G., Wightman, A. (1983). Spt-Cpt Correlations. journal of geotechnical engineering, 109(11), 1449-1459.

[5] Ohta, Y., Goto, N. (1978). Empirical shear wave velocity equations in terms of characteristic soil indexes. Earthquake engineering & structural dynamics, 6(2), 167-187.

[6] Boulanger, R.W., Idriss, I.M. (2014). CPT and SPT based liquefaction triggering procedures. Report No. UCD/CGM.-14, 1.