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GEOPHYSICAL SURVEYS FOR GROUND MODELLING OF ASHGABAT CITY

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INTRODUCTION

An international cooperation project between Turkmenistan and Japan regarding earthquake disaster mitigation called "The Project for Improvement of the Earthquake Monitoring System in and around the Ashgabat City in Turkmenistan" is being conducted by The Academy of Sciences of Turkmenistan and Japan International Cooperation Agency (JICA). The project has a main objective of improving capacity for earthquake observation and earthquake hazard assessment in the city. The period of the project is from July 2017 to December 2020.

Within the project, both researchers from Institute of Seismology and Atmospheric Physics of the Academy of Sciences of Turkmenistan (hereinafter referred to as "the Institute") and experts from JICA have been developing ground models to depict the seismic intensity map for the pilot areas in Ashgabat City. The Institute had already published earthquake intensity maps not only for Ashgabat City but also for the whole Turkmen territory. It has been pointed out, however, that resolution and accuracy of the earthquake intensity map of Ashgabat City should be improved to adapt to urban modernization and population growth of the city.

As the first stage to improve the maps, characteristic of subsurface soils had been studied using accumulated drilling data and existing geophysical survey results. Through these studies, it was recognized that the relationship between shear-wave velocity and ground condition including soil types and their properties are not sufficient to construct ground models. Therefore, geophysical surveys such as array microtremor survey, MASW (multichannel analysis of surface-waves) and PS- logging and borehole drillings with SPT have been carried out at around ten (10) locations in the city. In the meanwhile, researchers of the institute have been providing shear-wave velocity profiles at more than 1000 locations in the city by the improved HVSR (H/V spectral ratio) method.

We are processing field data provided by the borehole drillings and geophysical surveys to find relationships between soil conditions and shear-wave velocities in Ashgabat city area. In addition, comparison of shear-wave velocities obtained by several different methods, namely PS-logging, array microtremor surveys, MASW and the improved HVSR method, are being studied.

METHODOLOGY

So far, array microtremor surveys conducted at five sites using four small all-in-one seismometers called TROMINO®

which is equipped with 3-component velocity sensors and GPS receiver. The triangle array was utilised for the surveys. Combination of different triangle array sizes of a side length of 100 m, 50 m, 25 m, 13 m and 5 m was applied to obtain shear-wave velocity profile of a depth of down to about 100 m. The four (4) seismometers were also utilized for MASW and the linear array microtremor survey at either 5 m or 10 m intervals.

For analysis of array microtremor survey and MASW, signals obtained by only the vertical component of the sensors were processed. Meanwhile, signals obtained by the two horizontal components together with the vertical component signal were processed for HVSR analysis.

The surveys were conducted nearby boreholes which were also drilled for the project. The depths of boreholes were approximately 35 m. The standard penetration test (SPT) was carried out as well.

In the near future, the downhole PS-logging survey will be performed in the boreholes to obtain precise shear-wave velocity profiles. Furthermore, the shear-wave velocity profiles obtained by four different survey methods, namely PS-logging, the array microtremor survey, MASW and HVSR method, will be compared.

SURVEY RESULTS

Figure 1 shows shear-wave velocity profiles obtained by the array microtremor survey.

The figure displays that shear-wave velocity profiles down to around 60 m depths clearly increase in southern area of Ashgabat. This figure also suggests that shear-wave velocities at the near surface in Ashgabat tend to increase with elevation height.

Table 1 shows Vs30 values obtained both by the array microtremor survey (AMT) and by HVSR method. The results at only two sites can be compared because the data processing of HVSR at the remaining sites is not completed yet. It is however, Vs30 values obtained by both methods are consistent with each other.

We will obtain more field data and continue processing these data to construct accurate ground models for the earthquake hazard assessment.

Table 1. Vs30 values obtained by the array microtremor survey (AMT) and HVSR method.

Site Name	V_{s30} by AMT	V_{s30} by HVSR
BH10	243 m/s	265 m/s
BH09	467 m/s	421 m/s

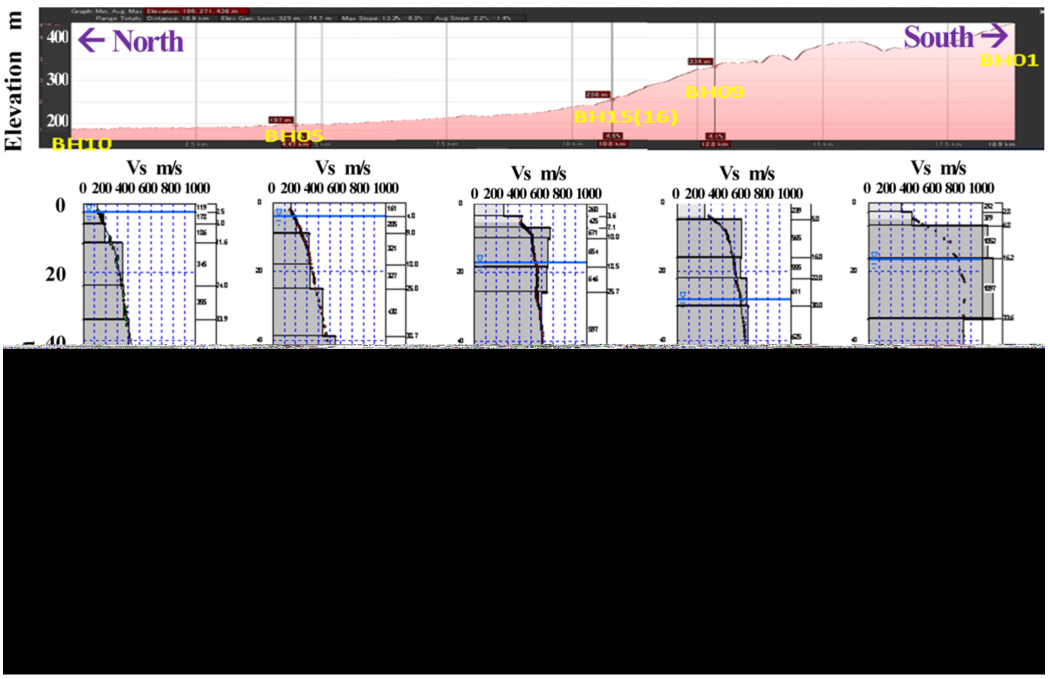

Figure 1. Survey location along the elevation section (above) and shear-wave velocity profiles (below).