Determination of dynamic characteristics of existing buildings at various site conditions in Eskisehir, Turkey

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The fundamental vibration period of a building is a crucial parameter for earthquake engineering. The equivalent seismic lateral force is determined from a design spectrum in most static design methods. Accordingly, the earthquake force is a function of the fundamental vibration period of the building. The fundamental period of an existing building can be determined by both forced and ambient vibration measurements. In this study, ambient vibration measurements were conducted at 17 existing buildings including different structural styles (masonry and reinforced concrete) and heights (7 to about 65 meters) which are located at different site conditions in Eskisehir, Turkey. In ambient vibration measurements, two accelerometers were placed on the top of the buildings and one accelerometer was placed on the ground. The fundamental vibration periods and the dampings of the measured buildings were evaluated. The fundamental vibration periods of the buildings were evaluated by picking the peaks of the spectral ratios of Fourier spectra on the top floor of buildings to those on the ground. The dampings of the measured buildings were estimated by fitting the spectral ratios calculated using a single degree of freedom system to the spectral ratios observed, in the process of trial and error (Iwata and Tsuno, 2013). In order to understand the site conditions near the buildings, array microtremor observations by small-scale arrays of 1.5 to 16 meters were performed on the free field. SPAC method was used to obtain the phase velocities of Rayleigh waves and the S-wave velocity profiles were estimated using those phase velocities in the inversion technique. Tsuno et al. (2018) derived an equation of T=0.016H from 10 building measurements carried out in Eskisehir, Turkey. In this study, 7 more measurements were added to the previous measurements of Tsuno et al. (2018) thus, according to findings of this study, the equation of T=0.0165H was proposed to estimate the fundamental vibration period (T, in seconds) of an existing building in Eskisehir, Turkey with respect to its height (H, in meters). This equation is still in need to improve with additional measurements, which could represent most of the building heights in the Eskisehir building inventory. The calculated dampings of the measured buildings have a general tendency that the higher the buildings, the smaller the dampings.

Acknowledgment

This study is supported by the Joint Research Project under the Bilateral Program of the Japan Society for the Promotion of Science (JSPS) and The Scientific and Technological Research Council of Turkey (TUBITAK) under Grant TUBITAK 116Y524.

References

Iwata, N., and Tsuno, S. (2013). Estimation of vibration characteristics and seismic responses of railway viaducts using microtremors data. In *Proceedings of the 11th SEGJ International Symposium, Yokohama, Japan, 18-21 November 2013* (pp. 286-289).

Tsuno, S., Yamanaka, H., Kaplan, O., Arslan, M. S. and Ozel, O. (2018). Characteristics of building vibrations estimated in various site conditions in Eskisehir, Turkey. In *Proceedings of the 13th SEGJ International Symposium, Tokyo, Japan, 12-14 November 2018.*

Keywords: Ambient Vibration Measurement, Fundamental Vibration Period, Damping, Array Microtremor Observation

