I-B 209 SYSTEM IDENTIFICATION FROM MICROTREMOR MEASUREMENTS

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1. Introduction: Microtremor measurement has become a powerful tool for engineers in order to estimate ground motion characteristics, amplification of soil deposits (H/V-ratio) [1], microzonation [2] and dynamic behavior of existing service structures [3]. The most advantageous side of using microtremors for engineering purpose is in its simplicity and convenience. Hereby, in this work, microtremor record analysis was elucidated and results compared with, first, FEM (S-ALUSH) and then down-hole measurement so as to examine the effectiveness of approach.

2. Site measurements: Microtremor measurements were performed in O- and A-areas of Tokyo metropolis, from November 21 to 22, 1995. The purpose of measurements were to investigate the site characteristics of areas, dynamic behavior of service structures and their stability control. Each measurement has a length of 120s. with a time increment 0.01s. Measurements were made on both free-field and service structures. Total 19 records were obtained at pre-defined points for each area. Each record has three channels, two for horizontal and one for vertical components of micro-excitation. The signals, after being amplified and digitized by using SPC-35F, are recorded on the hard-disk of a lap-top computer, enabling further record analysis.

3. Analysis of records: The origin of the microtremor is thought to be a white noise caused by a variety of sources. The white noise involves a family of frequency components with more or less similar magnitude. However, when the motion is recorded at the ground surface, it is found that components of some frequencies are much more intense than others. This is because of resonance in which components whose frequency is equal to the natural frequency of the local ground are magnified significantly, while other components are not. Consequently, it is expected that the Fourier analysis of the measured record would give us an important information of the dynamic nature of the ground. In order to determine the predominant frequency of site, two situ measurement and FEM (S-ALUSH) analysis were performed and compared. Using down-hole measurements, it may be determined theoretically the shear-wave velocity (V_s) of ground and corresponding predominant frequency at subsurface layer [$f = V_s/4H$]. On the other hand, H/V-ratio is based on ratio of horizontal to vertical smoothed Fourier spectra of microtremor data. Fourier analysis of records were done by dividing undisturbed (not impulsive) part of each record into 6 sections, with a length of 20s., and taking their average (Fig.1). Sections with very high direct noise were cut out. These disturbances are generally excited by human activities (cultural noise) such as traffic and machinery, or wind as a natural noise. Smoothing of spectra was done by using Parzen window 0.4Hz width. The frequency value coincides with peak of the ratio, were defined as predominant frequency of that soil deposit. For each area one down-hole measurement result has been obtained. Two points of microtremor records, CR-1 for O- and LR-8 for A- area, were selected for comparison with down-hole method. Comparison showed fairly good agreement (Fig.2). The most important service structure in both area is tower. Tower has a fundamental role to increase water pressure level, deposit and supply to customers and households around that area. The main problem is nondestructive detection of these old existing structures. The cheapest and simplest way to determine dynamic behavior of structure is to use microtremor. Spectral ratio analysis were performed for different levels of tower measurement points, (H_i/H_o), (V_i/V_o), (Z_i/Z_o). Results are in

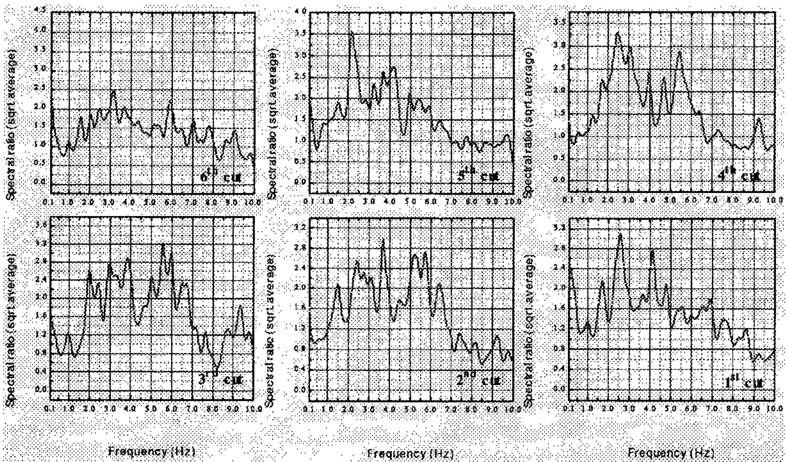
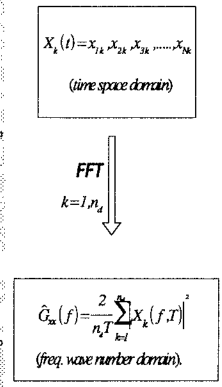


Fig.1 Spectral ratios (H/V-ratio) for point CR-1 at O-area ground surface.



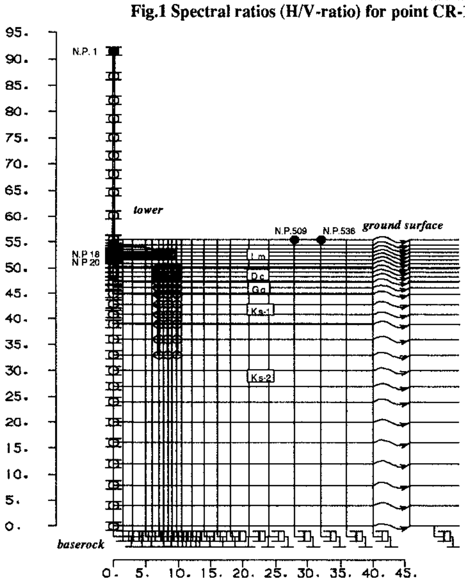


Fig.3 Mesh used in 3D FEM analysis (S-ALUSH)

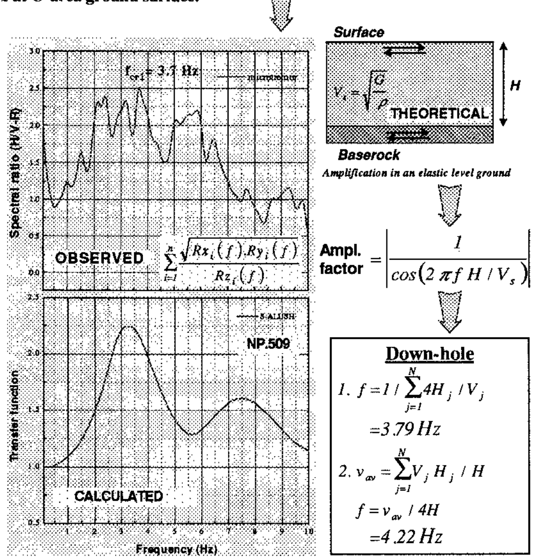


Fig.2 Comparison of methods to estimate natural frequency of soil site.

good agreement with FEM [S-ALUSH] (Fig. 3,4).

4. Conclusion: Microtremor record analysis were performed on specific areas so as to estimate the dynamic characteristics of ground and towers. Observed microtremor results have shown good coincidence with FEM and down-hole in-situ measurements both analytically and theoretically. However, microtremor analysis is not sufficient to determine the highly nonlinear behavior of deep soil deposit. Nevertheless, it is a useful tool for engineers to handle the problem of earthquake resistance.

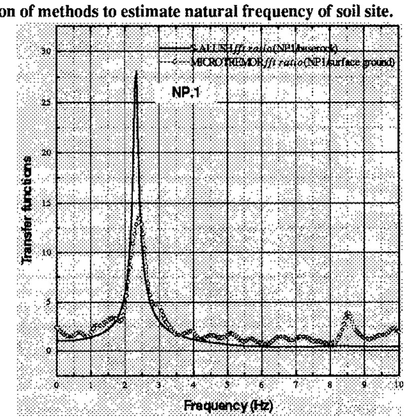


Fig.4 Comparison of transfer functions at point NP.1

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[3]. T.Ganev, F.Yamazaki, T.Katayama. *Observation and numerical analysis of SSI of a RC tower*; (EESD, Vol.24,491-503 1995).