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Construction of analytical subsoil models in ground shaking scenarios using H/V ratios of ambient noise

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Estimating the seismic hazard for a study area of 120 km^2, including three towns and surrounding settlements in the central part of Israel, is made by detailed mapping of the characteristics of the H/V spectral ratios from ambient noise and further incorporating geological, borehole and geophysical information to construct subsurface model. The ambient noise survey is carried out at 580 sites, part of which is located at boreholes. The soil sites exhibit H/V peak amplitude ranging from 2.5 up to 8 units within the frequency band of 0.4-13 Hz. The resonance frequencies and their associated H/V levels are correlated with the subsurface geology. The soil profiles at the investigated sites consist of Senonian-Pleistocene deposits represented by marl-chalk, clay and sand or sandy loam overlying dolomite of Turonian age, which is a fundamental reflector. According to the geological data, sedimentary thickness ranges from a few meters up to 600 m in the study area. A less distinct impedance contrast between upper sand-sandy loam layer and Pliocene clay or Senonian marl-chalk produces additional resonance.

S-wave velocities from a few seismic refraction surveys carried out close to borehole locations, where thickness of sedimentary layers is known, enabled the calibration of the H/V spectral ratios with an analytical site response derived from a 1D subsurface model. It is also utilized to constrain Vs and thickness values of subsurface models and obtain a systematic match between the observed H/V ratios and the evaluated site response functions.

Extensive database of ambient vibration measurements is used for analysis of an empirical relationship between fundamental frequency and thickness of the soft sediments. We obtain unsatisfactory results in terms of accurately estimates of the thick-

ness of the soft sediments. Scatter amongst observations in cross-plot of the fundamental frequency vs. depth of the fundamental reflector is very large.

Detailed analysis of this relation shows that the reasons of error lay not only in the initial data themselves due to very limited availability of drilling logs, for example, but rather in simplification of the subsurface model as a single layer over half-space. It is clearly seen while comparing fundamental frequency with sediment thickness derived from 1-D model constructed by fitting of analytical transfer function to H/V ratio considering all the resonance peaks and their associated amplitudes. We note that the thickness and velocity of intermediate hard layer existing almost everywhere significantly influences the calculated reflector depth. Thickness of upper soft layer above the intermediate hard one also indirectly affects the fundamental reflector depth.

The results have demonstrated that the research method using fundamental frequency-depth dependence to determine sediment thickness is not appropriate for the study area and does not allow a reliable construction of a realistic model of the site response. Microtremor measurements in combination with analyzing H/V spectral ratios provide a systematic picture of the characteristics of the site effects for the application in ground shaking scenarios.