Nonlinear response of surface layers at KiK-net stations

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It is well known that soft surface layers show nonlinear characteristics under a condition of large strain. However, dynamic behavior of soils during strong shaking due to actual earthquakes have not been well known because of the lack of data.

Accelerometers are installed on the ground surface and at a depth of 100 m at each KiK-net station. Underground structure is well known at the stations. Therefore, analysis of strong motion records at KiK-net stations leads us to understanding actual dynamic behavior of soils during earthquakes.

Transverse component accelerograms are analyzed for the 2000 Tottori-seibu earthquake and its aftershocks. The maximum accelerations of borehole records at SMNH01 and TTRH02 are more than 250 gal for the main shock. At these stations, spectral ratio between surface and borehole records shows obvious nonlinear behavior of surface layers. The peak frequency of the spectral ratio for the main shock is lower than those for the aftershocks. The amplitude of the spectral ratio is smaller for the main shock than those for the aftershocks in the frequency range higher than 2 or 3 Hz.

At TTRH02, a gravel layer with a thickness of about 10 m lies on a granite layer. Although the shallow part of the granite layer may be weathered, it is assumed that the granite layer behaves linearly in the present preliminary analysis. Only the gravel layer is assumed to have nonlinear characteristics.

Accelerograms expected at ground surface are calculated from observed borehole records and assumed strain dependency of the rigidity and damping ratio for the surface layers. The strain dependency of the rigidity and the damping ratio for the gravel layer is evaluated by trial and error method. The maximum strain is estimated to have been more than 1% in the gravel layer during the main shock.

Acknowledgements: KiK-net data are provided by National Research Institute for Earth Science and Disaster Prevention. One dimensional nonlinear response analysis software (MDM) used in this study was developed by Dr. Kumazaki of Chubu Electric Power Co., Inc.