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Strong Ground Motions during the 2011 Tohoku Earthquake at the Vertical Array inside Onagawa Nuclear Power Plant

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Strong ground motions during the 2011 off the Pacific Coast of Tohoku Earthquake occurring on March 11, 2011, were observed in the Onagawa Nuclear Power Plant. The maximum acceleration of 692gal (the NS direction) was obtained during the main shock. It is necessary to evaluate the non-linear behavior of the surface layers in order to clarify the characteristics of thestrong ground motions on the important structures. In this study, the non-linear effects of the strong ground motions at the vertical array inside Onagawa Nuclear Power Plant are estimated using the one-dimensional reflection method with nonlinear coefficient.

First, we identified the underground structural model from aftershock records obtained in the borehole arrays using the simulated annealing method. Spectral ratios between surface and underground data are used for the inversion. Based on numerical experiments it is identified that P-wave velocity, S-wave velocity and Q values of individual layers are inverted very well.

Next, Strong motion records of main shock observed by the bore hole seismometers were simulated by using one-dimensional multiple reflection method. In this study, non-linear effect is considered by introducing non-linear coefficient c (f) for downgoing waves from surface and P and S-wave velocities B(i) for in the non-liner soil layer during main shock. The simulated waveforms obtained from this method show good agreement with the observed seismograms in the borehole stations.

In conclusion, the results indicate that non-linear effects of surface layers on the main shock motions are limited in shallow depths of 5 meters, in Onagawa Nuclear Power Plant.

Keywords: 2011 off The Pacific Coast of Tohoku Earthquake, Strong ground motions, Simulated annealing, Non-linear coefficient, Identification