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Effect of the non-linearity of the ground in synthetic ground motion by using Empirical Green's Function

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In seismic hazard in an engineering problem, it is required to consider the ground motion in a period band of about 10 seconds from 0.1 seconds. Strong ground motion in a period range of less than one second are controlled by generation region called [asperity] on a fault plane. The short-period component, is also strongly influenced by characteristics of the propagation path effect. In order to obtain such effects theoretically it is required a huge amount of calculation and data for underground structure. It is also necessary for more accurate evaluation method of ground motion.

In this, we calculate synthesis ground motion of main shocks for past events by using the empirical Green's function method, and to assess the effects of the non-linearity of soil from the difference between the observed and synthesis waveforms.

We compared the observed waveforms and synthetic waveforms at the observation point K-net during five crustal earthquakes occurred in Japan, using the source model obtained by the inversion in the past. We used characterized source models that has been obtained in previous studies, first, I was examined how much the non-linearity effects of soil are included at the observation point by comparing the observed and synthetic waveforms. When PGAs are more than 200gal, PGVs are greater than or equal to 10kine, the synthetic waveforms tend to be significantly different from the observation waveforms. In order to evaluate quantitatively the nonlinearity of the soil of each observation point, using (which was summed in the frequency domain for each ratio of H / V spectrum at the aftershocks and the main shock) DNL method, we examined the relationship DNL and the PGA. Then, for the PGAs above 200 gal, the DNL has become equal to or greater than 6, and the DNL for PGA of 200gal is about 4. We have found that DNL is one of good parameters to evaluate the nonlinearity of the soil. This is also consistent with the results by Noguchi (2009). Next, we evaluated the effect on PGV and PGA ratios (synthesis/observations) with the difference condition of subsurface structure. We used the difference of each Vs20 which is the S-wave velocity average of up to 20m depth as parameters for the soil condition. In spite of the differences in the Vs20, the relationship between the Vs20 and PGA or PGV ratios is not so clear. One of the reasons for this is that the used characterized source model only asperity source model, was not sufficiently tuned model for all sites.

We try to assess the effects of nonlinear amplification by quantitatively evaluating the difference between the synthesized waveform and the observed waveform and adding to the result of empirical Green's function method. However, the PGA and PGV from observed waveform cannot good parameters for this evaluation, because of including high frequency pulses Different evaluation criteria, such as seismic intensity and spectral integration value will be examined.

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Keywords: Empirical Green's Function, non-linearity of soil, DNL, strong motion