Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

MAG022-06 Room:国際会議室 Time: May 28 10:15-10:30

Deep sediments in Metro Manila, Philippines inferred from the Joint Inversion of Receiver functions and Surface waves

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Metro Manila, the capital of the Philippines is situated in Luzon Island. Its total population is more than 10 million living in a total land area of 640sq.km, making it the most densely populated area in the Philippines. Metro Manila is transected by 135 km long right lateral strike slip Valley Fault System (VFS) or sometimes called the Marikina valley fault. The estimated earthquake magnitude for the VFS for a single-event fall within the range of magnitude 7.3-7.7 (Rimando and Knuepfer 2 006). Moreover, the paleoseismic data of VFS indicated a recurrence interval of 200-400 years for magnitude 6-7 earthquakes over the past 1500 years (Nelson et al. 2000). With a clear idea of VFS and the hazard that it will produce, the need to conduct detailed study of sedimentary layers is essentially important in estimating site response.
Since 1998, ten strong motion seismometers have been operated by Philippine Institute of Volcanology and Seismology (PHIVOLCS) and Tokyo Institute of Technology to observe the strong ground motions and different amplifications from different geological setting in Metro Manila. The geomorphologic feature of Metro Manila is divided into three districts; the Central Plateau, Coastal Lowland and the Marikina River Plain or Flood Plain. As of December 2008, a total of 133 earthquake events have been recorded by the strong motion array with magnitudes ranging from 2.3 to 6.8. With these 11-year strong motion records the receiver function analysis could be performed.
In this study, genetic algorithm (GA) was applied in the joint inversion of receiver function (RF) and surface-wave phase velocity to determine the shear-wave velocity structure of deep sedimentary layers. Using water-level method of calculating receiver functions in the analysis of 1 1-year earthquake data of strong motion accelerographs, the observed RF contains seismic phases generated from P-S conversions at velocity discontinuities. To investigate the result of receiver function alone, a receiver function inversion method using genetic algorithms is applied for earthquake records to obtain 1-D S-wave velocity profile. Inversion of strong motion receiver function has provided much general information about the shear velocity structure in Metro Manila.
Results from receiver function inversion are further improved by joint inversion together with the dispersion of surface-wave from long period microtremor measurements. The dispersive features of surface phase velocities from long-period microtremor array measurements conducted by Yamanaka et al. (2000) in Metro Manila exhibit the propagation of Rayleigh waves. By applying the joint inversion, preliminary models were used in the successful determination of S-wave velocity profiles and these models were based on previous studies and results related to the substructures of Metro Manila. The GA that was implemented here for the joint inversion is similar to that of Takekoshi and Yamanaka (2009), which is a modified GA of Yamanaka and Ishida (1996). The method adopted a real number coding and introduced an elite selection and dynamic mutation, except for the definition of misfit, which will be minimized in the inversion. For the GA parameters, the population size and rates of crossover and mutation were set to be 20, 0.7, and 0.01, respectively. Selection was performed according to a roulette rule. The inversion result was evaluated after 10 repetitions of a 100-generation calculation with different seeds of random

number generator.
The result shows the inferred deep sedimentary layers in Metro Manila that will be used for further study on seismic hazard analysis. The identified deeper sediments are significant to distant earthquakes since deep sediments on a basin structure excite longer periods. Thus, the high rise buildings situated on this area will be greatly affected.

Keywords: Receiver function, surface wave phase velocities, genetic algorithms