A Recipe for Microzoning Aimed to Earthquake Disaster Prevention

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"National Seismic Hazard Map" has been making as one of the national projects integrating all fields of earthquake researches such as active fault, earthquake forecast and strong motion prediction studies after the 1995 Kobe earthquake. The map consists of two parts made from two different approaches, probabilistic and deterministic. The probabilistic seismic hazard map is shown as the predicted likelihood of a ground motion level such as PGA, PGV, and seismic intensity occurring in a given area within a set period of time. It provides important information for land planning, design standards of structures and people's enlightening as to seismic risks. The deterministic seismic hazard map is shown as the distribution of the ground motion level predicted for individual specific earthquakes assuming their fault models. The strong ground motions at specific sites near each source fault are estimated as time history, based on a "recipe" characterizing the source and numerical synthesis of waveforms with a hybrid scheme.

The source fault model for the map is defined based on a "recipe" which has been made with information about active fault surveys scaling relations of fault parameters, and characterized source model from the waveform inversion of rupture processes using strong motion data. Verification and applicability have been examined by comparing synthesized ones estimated using the "recipe" with observed ground motions from recent disastrous inland-crustal-earthquakes such as the 2005 Fukuoka Seiho-oki earthquake, the 2007 Niigaka-ken Chuetsu-oki earthquake (Mw 6.6), the 2008 Iwate-Miyagi Nairiku earthquake (Mw 6.9) and so on. Ground motions from these earthquakes are found to be predictable as long as the source fault is specified through investigation of active folds and faults. Further, we attempt to simulate strong ground motions during the 2008 Wenchuan earthquake of Mw 7.9 assuming the characterized source model.

The technique of the strong motion prediction mentioned above is introduced to the "Regulatory Guide for Aseismic Design of Nuclear Power Reactor Facilities" revised in 2006 by the Nuclear Safety Commission of Japan (NSCJ). The NSCI decided "Seismic Reevaluation Recommended on Existing NPPs Based on the Revised Seismic Design Guide," for the existing nuclear power reactor facilities to verify their seismic safety against the revised version of the Seismic Guide (back-checks).

The Niigataken Chuetsu-oki Earthquake occurred on July 16, 2007 near the Kashiwazaki-Kariwa Nuclear Power Station has given significant damages to non-safety related equipment, although the units in operation were safely shut down as designed. Specially to note is that this earthquake has reminded the regulatory bodies, utilities, etc, of quite a number of challenging issues to tackle in ensuring seismic safety of nuclear facilities. There was recorded ground acceleration of 680 gals on the base mat of Unit No.1 reactor, 2.5 times more than the ground motion levels for aseismic design of facilities. The active faults caused to the earthquake have not been specified in evaluating input ground motions for the aseismic design. We made careful examinations why the active faults have been missed and how the ground motions have been underestimated. We found that the ground motions from the earthquake were predictable as long as the source fault is specified through investigation of active folds and faults.

In the growing interest in nuclear power worldwide, this earthquake raised significant concerns even in other countries. It is important to provide the experiences in Japan to share worldwide scientific and technical knowledge on seismic safety which has been obtained so far.