Preliminary Seismic Safety Evaluation of Radioactive Waste Disposal Facility Site (Centering around RWD seismic station) Considering 2016 Gyeongju Earthquake

Hoseon Choi [a*], Seung Gyu Hyun [a]
[a]*Korea Institute of Nuclear Safety, 62 Gwakak-ro, Yueong-gu, Daejeon 34142*
[*]*Corresponding author: hoseon@kins.re.kr*

1. Introduction

The seismic safety evaluation procedure of the radioactive waste disposal facility site is almost the same as that of the nuclear power plant site. In other words, through the evaluation of geological and seismological characteristics of the region within a radius of 320 km from the site and the detailed geological survey of the area within a radius of 8 km from the site, the maximum ground motions expected are compared with the design ground motions of the site.

In this study, strong ground motions at RWD seismic station by a scenario earthquake on the causative fault of 2016 Gyeongju earthquake are simulated by using stochastic and empirical Green's function (EGF) methods, and are indirectly compared with the standard design response spectrum of RG 1.60 [1] (anchored to 0.2 g and 0.3 g) at the site. RWD seismic station has been operated by Korea Institute of Nuclear Safety (KINS) since 2016 and is located within low and intermediate-level radioactive waste disposal facility site.

2. Methods and Results

The stochastic and an empirical Green's function (EGF) methods are preliminarily applied to simulate strong ground motions at RWD seismic station considering an assumed large earthquake with M_W6.5 (scenario earthquake) on the causative fault of 2016 Gyeongju earthquake with M_W5.5 (mainshock). In the stochastic method, a ratio of spectral amplitudes of observed and simulated waveforms for the mainshock is assumed to be an adjustment factor [2]. In the EGF method, strong ground motions by the mainshock are simulated assuming strong ground motions by 2016 Gyeongju earthquake with M_W5.0 (foreshock) as the EGF. To simulate strong ground motions by the scenario earthquake, a ratio of fault length to width is assumed to be 2:1 in the stochastic method, and strong ground motions by the mainshock are assumed to be EGF in the EGF method.

2.1 Stochastic Method

The EXSIM code is used for strong ground motion simulation by the stochastic method [3]. It is an open program for a stochastic simulation algorithm considering the finite fault written in FORTRAN, which yields strong ground motions by earthquakes. Simulated waveforms and response spectra at RWD seismic station are presented in Fig. 1.

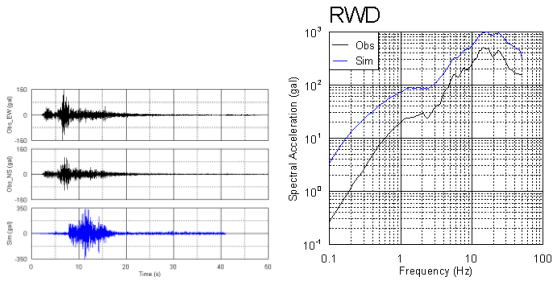

Fig. 1. [left] Observed (black solid line) and simulated (blue solid line) waveforms. [right] Observed (black solid line) and simulated (blue solid line) response spectra.

2.2 EGF Method

The EGFM code is used for strong ground motion simulation by the EGF method [4]. Simulated ground motions of the scenario earthquake by assuming that ground motions by the mainshock are EGFs, with east-west and north-south components are presented in Fig. 2.

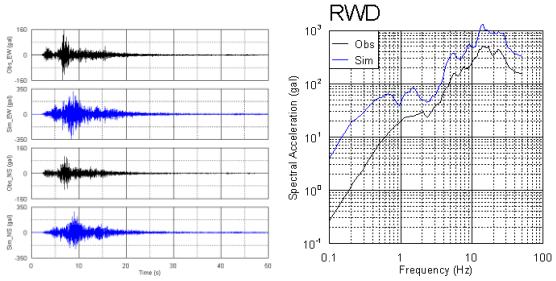

Fig. 2. [left] Observed (black solid line) and simulated (blue solid line) waveforms. [right] Observed (black solid line) and simulated (blue solid line) response spectra.

2.3 Comparison of Simulation Results

Fig. 3 shows comparisons of response spectra by the stochastic method with the consideration of an adjustment factor and the EGF method for the scenario earthquake. Overall, two response spectra at RWD seismic station are similar to each other. Simulated waveforms by the EGF method show weak deficiencies of spectral amplitude in intermediate frequency. Fig. 3 also shows horizontal standard design response spectra of RG 1.60 [1] (anchored to 0.2 g and 0.3 g). Simulated response spectra at RWD seismic station by two

methods are found to exceed significantly RG 1.60 [1] response spectra in a frequency band around 10 Hz. However, there is a big difference compared to the results of the nearby (~2.4 km) WSN seismic station, so it is necessary to closely check the appropriateness of the installation of RWD seismic station.

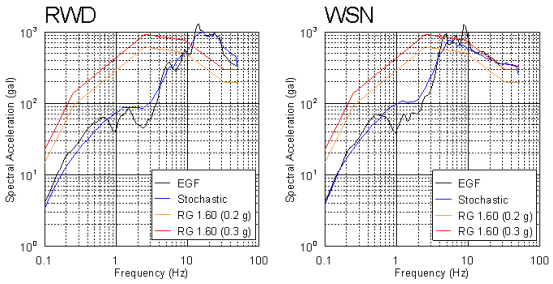

Fig. 3. [left] Simulated response spectra by the stochastic method (blue solid line) and EGF method (black solid line) for RWD seismic station and [right] for WSN seismic station. Horizontal standard design response spectrums of RG 1.60 [1] anchored to 0.2 g (orange solid line) and 0.3 g (red solid line) are also depicted.

2.4 Comparison with Ground Motion Prediction Equation

Peak ground accelerations (PGAs) by a recently developed ground motion prediction equation (GMPE) in South Korea [5] substituting the magnitude (M_W6.5) are compared with those by strong ground motion simulations. Fig. 4 shows the results of comparing PGAs of observed ground motions with those of simulated ground motions by two methods. PGAs by the two methods are located at the lower part of PGA ranges by the GMPE.

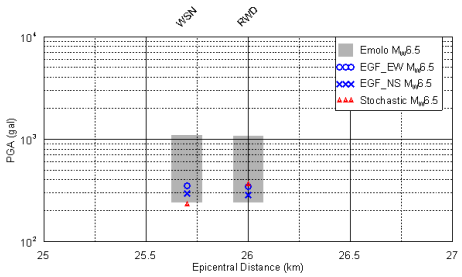

Fig. 4. Comparison between PGAs by the stochastic method (red triangle) and by the EGF method with EW (blue circle) and NS (blue x) components, and PGA range by GMPE (gray box) for an M_W6.5 earthquake (scenario earthquake)

3. Conclusions

The stochastic and EGF methods are preliminary applied to simulate strong ground motions at RWD seismic stations within low and intermediate-level radioactive waste disposal facility site by an assumed large scenario earthquake with M_W6.5 on the causative fault of 2016 Gyeongju earthquake. Simulated response spectra by two methods have been found to exceed significantly RG 1.60 [1] response spectra in a frequency band around 10 Hz, but considerable attention to interpretation is required since the assumed input data was used. Also, there is a big difference compared to the results of the nearby WSN seismic station, so it is necessary to closely check the appropriateness of the installation of RWD seismic station.

Meanwhile, various studies are currently being conducted by geological, seismological, geophysical, and geotechnical investigations to verify the causative fault of the mainshock, so the magnitude of the scenario earthquake could be modified.

REFERENCES

[1] U. S. Nuclear Regulatory Commission, Design response spectra for seismic design of nuclear power plants, Regulatory Guide 1.60 Rev. 2, 2014.
[2] H. Choi, Stochastic strong ground motion simulation at South Korean metropolises' seismic stations based on the 2016 Gyeongju earthquake causative fault, Journal of Earthquake Engineering Society of Korea, Vol.25, No.6, pp.233-240, 2021. (in Korean)
[3] G. M. Atkinson, and K. Assatourians, Implementation and validation of EXSIM (a stochastic finite-fault ground-motion simulation algorithm) on the SCEC broadband platform, Seismological Research Letters Vol.86, No.1, pp.48-60, 2015.
[4] K. Irikura, and H. Miyake, Lecture note on strong ground motion seismology, 8th Workshop on Three-Dimensional Modelling of Seismic Waves Generation, Propagation and their Inversion, Trieste Italy, 25 Sep.-7 Oct. 2006.
[5] A. Emolo, N. Sharma, G. Festa, A. Zollo, V. Convertito, J. H. Park, H. C. Chi, and I. S. Lim, Ground-motion prediction equations for South Korea Peninsula, Bulletin of the Seismological Society of America, Vol.105, No.5, pp.2625-2640, 2015.