The Development on Evaluation Response Spectrum for the Seismic Risk Evaluation of a Nuclear Waste Repository

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1. Introduction

Long-term disposal and management of low and intermediate-level radioactive waste is a major project of the nuclear power industry. Therefore, the selection of an underground waste repository has to be a geologically and seismologically stable storage. Easy transportation and emplacement is essential. The Wolsung nuclear power plant (NPP) of unit no. 1/2/ 3/ 4, which is responsible for the future of the energy industry, has already been constructed at the Wolsung site and a New NPP has recently been created at the Sinwolsung site. Radioactive waste used in the plant facilities, has piled up increasingly every year, but it should be taken to be managed at long-term underground storage disposal facilities.

The Wolsung site for radioactivity waste repository was known to be relatively stable through various geological surveys, earthquakes, groundwater, engineering testing and analysis, but still more research related to the stability of the structure, in deep underground tunnels of several hundreds of meters, is needed. This study was conducted to simulate the ground motion spectrum in bedrock and to understand the seismic response analysis of bedrock by using P-CARES [1]. The physical properties used in this study were gathered in drilling data at the Wolsung site and the ground characteristics were simplified depending on the depth.

2. Methods and Results

First, the selection of the uniform hazard spectrum was required to derive the curve of the hazard spectrum of bedrock at the Wolsung site. Frequency-response data of a uniform hazard spectrum, using the P-CARES program generates 30 synthesized ground motions and then checks that average spectrum of synthesized ground motion, has a similar value to uniform hazard spectrum. Each synthetic seismic has been analyzed as a response spectrum using the program depending on the depth of the target and the average of results have compared with uniform hazard spectrum. Finally, amplification characteristics of the spectrum changed by ground properties have studied.

2.1 Selection of the hazard spectrum

The hazard spectrum was selected by spatial zonation on the seismic source of the best estimate or alternative estimate. The best estimate was characterized as and area seismic source that was assumed to be uniform in seismic activity and other characteristics within the seismic source. Also, the seismic of the special zone lead to similar genetic tectonic settings or generates the possible seismic of time, space and size is simplified[2]. The expert groups have classified into several seismic sources, depending on frequency of earthquakes on the Korean peninsula by historical and instrumental earthquake data. Figure 1 shows the uniform hazard spectrum and annual exceedance probability in study area.

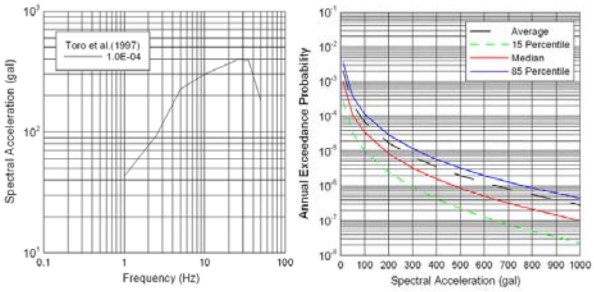

Fig. 1. Uniform hazard spectrum selected by spatial zonation and annual exceedance probability in study area.

2.2 Generation of synthesized ground motion compatible with uniform hazard spectrum

The synthesized ground motions compatible with uniform hazard spectrum were generated by using P-CARES program which was developed for the seismic response analyses of simple soil and structural model by Brookhaven National Laboratory (BNL) under a Nuclear Regulatory Commission (NRC) and involve the estimation of the effect on structure at a particular site. Also, this program was convenient to use and can generate a number of the response spectrum with single input data as soon as possible.

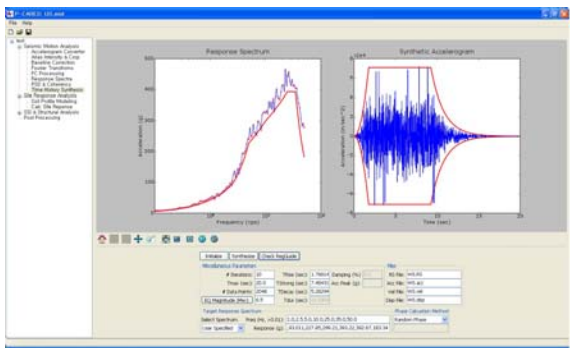

Fig. 2. A response spectrum and synthetic accelerogram generated by using the P-CARES program.

Fig.2 shows the target response spectrum and the time history generated with conditions. The average value of the 30 bits of data which were gotten through this repetitive computer operation matches the uniform hazard spectrum well as in Fig. 3.

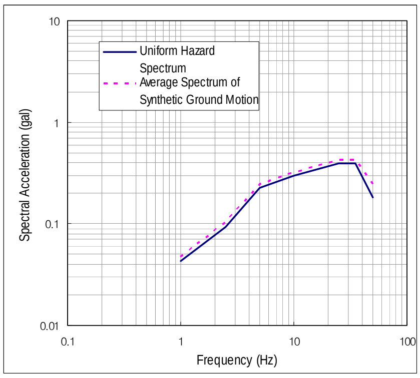

Fig. 3 Average spectrum of synthesized ground motion matches up with uniform hazard spectrum relatively.

2.3 Preparation input data for evaluating seismic risk

This study was done to know more about the site amplification of a radioactivity waste repository. To do this, the underground area was divided 4 into engineering geological layers and then the bottom layer was subdivided into three zones, namely the outcrop, crown and invert of the repository. Table 1 shows input data for analyzing the ProShake program. There were depths and physical properties of each layer. However, the shear wave velocity of medium rock was assumed to be the proposed velocity in the seismic design regulations II, since there wasn't any data of the shear wave velocity of medium rock.

Table I: The property of Soil layer and bedrock in depth

	Soil layer	Weathered rock	Medium rock
Density(g/cm^3)	1.65	1.90	2.70
Vs(m/s)	628.0	745.0	1500
Layer thickness(m)	4.3	5.2	23.5
Poisson's ratio	0.33	0.3	0.27
	Hard rock		
	Outcrop	-80(EL. m)	-130(EL. m)
Density(g/cm^3)	2.70	2.90	2.90
Vs(m/s)	1500	2580	3074
Layer thickness(m)	80.0	50.0	70.0
Poisson's ratio	-	0.23	0.12

The ProShake program generated the response spectrum in depth when the synthesized ground motion was entered into the program. The response spectrum thus gained was averaged in depth and plotted on the graph as following Fig. 4

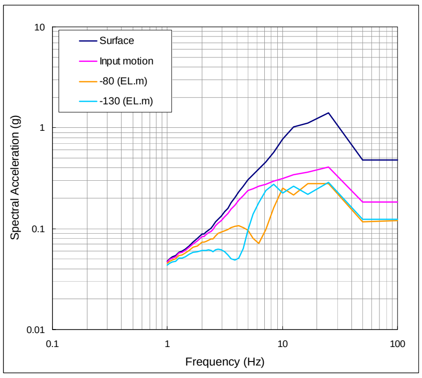

Fig. 4 Comparison of the response spectrum based on depth.

Fig. 4 shows that the site amplification ratio of radioactivity waste repository dropped in a high frequency range compared with the input motion and there was little difference between the crown and invert of repository in the high frequency zone. While, the site amplification ratio of the surface increased in a low frequency range, it means that the surface is composed of soft ground compared to the repository ground.

3. Conclusions

Seismic response spectrum of bedrock has been developed to assess the seismic risk in the Wolsung radioactivity waste repository. The results of the study on the response spectrum of 30 ground motions, the bedrock is located in deep underground, has characteristics that reduce spectral acceleration for a high frequency domain, but doesn't show significant reduction through the depth. Therefore, it seems possible that the assessment of the seismic risk for the repository site should be analyzed by single spectral acceleration.

ACKNOWLEDGEMENT

This work was supported by Energy Research & Development Program of the Korea Institute of Energy Technology Evaluation and Planning (KETEP) grant funded by the Korean government (MKE)

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