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Deconvolution of the surface ground motions at the LILW complex disposal facility for the seismic analysis

Jeong-Gon Ha [a*], Minkyu Kim[a]
[a]*Advanced Structural and Seismic Safety Research Division, Korea Atomic Energy Research Institute, 111, Daedeok-Daero 989 beon-gil, Yuseong-gu, Daejeon, Korea*
[*]*Corresponding author: jgha@kaeri.re.kr*

1. Introduction

Radioactive waste should be permanently segregated and disposed of in a separate place. In Korea, a Low and Intermediate-level radioactive Waste (LILW) complex disposal facility, including a silo disposal facility and a surface disposal facility, is being built and operated near Gyeongju [1]. It is necessary to secure the facility's safety against earthquakes disaster. For evaluating this safety, detailed seismic analysis results for the disposal facility are required.

Since the structure of the disposal facility is embedded in the ground, the interaction between the structure and the surrounding soil can significantly impact the seismic responses. Therefore, the seismic analysis should simulate not only the concrete structure of the disposal facilities but also the surrounding rock soil. And the input seismic motion should be applied to the lower part of the rock. In this case, the input seismic motions can be derived through deconvolution analysis from the rock surface motion [2].

In this study, the deconvolution process was studied for determining the input seismic motion for the seismic analysis of the LILW complex disposal facility. Variations in the deconvolution results of the surface ground motion were compared and analyzed according to the intensity of seismic motion, the shear wave velocity profiles, and the depth of the underlying bedrock.

2. Probabilistic Seismic Hazard Assessment

The target spectrum of motion at the rock surface of the LILW complex disposal facility site was determined using probabilistic seismic hazard analysis (PSHA). The solid red line in Fig. 1 is the uniform hazard spectrum derived from PSHA, and the design spectrum and the uniform hazards spectrums from other previous studies are also described. The derived spectrum showed more energy at high frequencies than the design spectrum.

3. Input Earthquake Motions at Rock Surface

The acceleration time histories compatible with the target spectrum were acquired by performing spectrum matching for the several recorded earthquake motions. It is ideal to use records of a strong earthquake at the target site, but it is not easy to secure a large number of earthquake records in a moderately weak earthquake region such as Korea. So, we used the seismic records from overseas with similar earthquake environments as well as the motions from the Gyeongju and the Pohang earthquakes. Fig. 2 shows the acceleration time histories of the seven seismic records used in this deconvolution analysis.

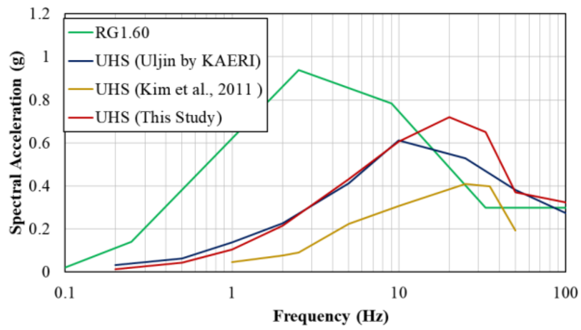

Fig. 1. Comparison of the uniform hazard spectrum at the LILW complex disposal facility site with other spectrums [3]

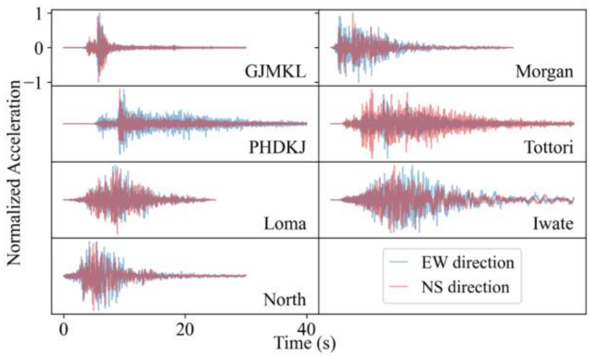

Fig. 2. Earthquake records used in the deconvolution analysis

4. Parametric Study on Site Response Analysis

Site response analysis is a technique to evaluate the ground's seismic responses according to the depth. It is divided into the convolution and the deconvolution analysis according to the analysis direction of transfer. The deconvolution analysis evaluates the change from the ground surface to the bottom. In this study, deconvolution analysis was performed by changing various input parameters for the LILW disposal facility site, and the results were compared.

4.1 Peak Ground Acceleration

The spectrum of the ground motion at the lower bedrock according to the intensity of the input motion at the surface was depicted in Fig. 3 As the seismic intensity increased, the spectrums of the transferred motions at the bedrock also increased. Even when the peak ground acceleration (PGA) was up to 1.5 g, the shape of the spectrum and the dominant frequency were not changed. It means that the soil's nonlinear behavior was not significant at this site.

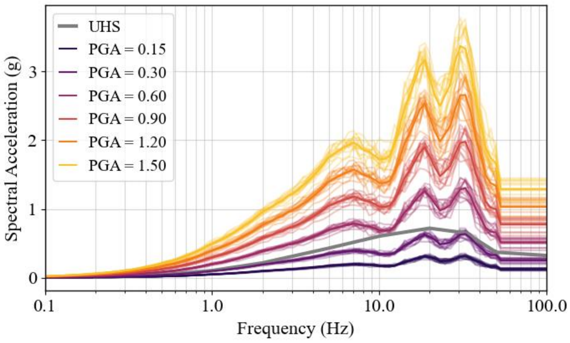

Fig. 3. Response spectrum at the lower bedrock according to the change in the seismic intensity of the surface motion

4.2 Shear Wave Velocity Profile

The soil shear wave velocity profile is one of the crucial variable that determines soil amplification and has large uncertainty inherently. Deconvolution analysis were performed with three shear wave velocity profiles. As shown in Fig. 4, the dominant frequencies of the spectrum at the lower bedrock varies depending on the shear wave profiles, but there were no specific trends in PGA.

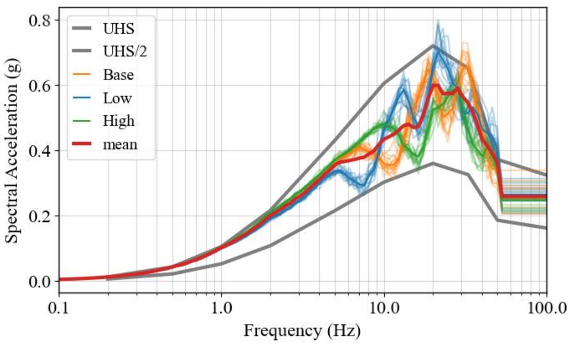

Fig. 4. Response spectrum at the lower bedrock according to the change in the shear wave velocity profile

4.3 Bedrock Depth

Since the rocky soil at the complex disposal facility site is stiff and deep, it is difficult to determine the bedrock depth for analysis. Fig. 5 shows the results of deconvolution analysis with different depths of bedrock. Overall, the spectrum shape and intensity from the analysis results were consistent regardless of the variation of the bedrock depth.

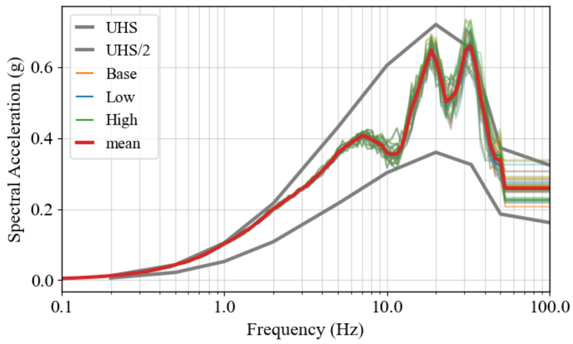

Fig. 5. Response spectrum at the lower bedrock according to the change in the bedrock depth

4. Conclusions

This study performed the deconvolution analysis by changing various parameters for the LILW complex disposal facility site. From the analysis results, the variations in spectral shape and intensity were observed according to the intensity of the surface motion and the shear wave velocity profile. However, the effects according to the soil's nonlinear characteristics and the bedrock depth were insignificant.

Acknowledgement

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