Evaluation of the Current Seismic Zone of Korea Based on the Probabilistic Seismic Hazard Analysis

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1. Introduction

The conventional Probabilistic Seismic Hazard Analysis (PSHA) gives seismic hazard curves which show the relationship between a seismic intensity such as a PGA (Peak Ground Acceleration) and its annual exceedance probability. The hazard curves are useful for engineering purposes because they can be used to determine the seismic intensity corresponding to the hazard level.

In general, the seismic zone factor for the seismic zone is used for the seismic design of civil structures or buildings. Korean peninsula is generally divided into two seismic zones in the seismic design guidelines.

In this study, the probabilistic seismic hazard analyses for 8 sites were performed. And the current seismic zones were estimated based on the results of the PSHA.

2. Seismic Source Model

In Korea, the active faults have not been definitely identified as seismic sources which generate earthquakes at the present time, and the historical data on the recurrence time for a specific earthquake has not been obtained. Therefore, the Poisson typed PSHA method was used, in which all the earthquakes are assumed to occur according to the stationary Process in the time domain.

Figure 1 shows the seismic source model used in this study. Several kinds of seismic source models have been proposed by seismologists. The seismic source model is generally used for the PSHA for NPP sites. So the seismic source models do not cover all of the Korean peninsula. In this study, the seismic source model which covers all of the Korean peninsula was chosen [1].

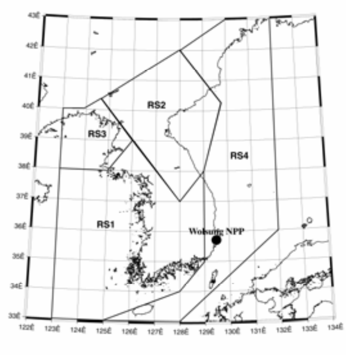


Fig. 1. Seismic Source Model

3. Attenuation Equations for the PSHA

The ground motion attenuation equations proposed by Toro et al. [2] were used for the PSHA. The attenuation equations for the peak ground acceleration and the spectral acceleration are as follows.

$$\ln PGA\left(cm/\sec^2\right) = 1.76 + 1.2M - 1.28\ln M - 0.0018R + 0.05\max\left(\ln\frac{R}{100}, 0\right)$$

$$R = \sqrt{R_{epi}^2 + 9.3^2}$$

$$\ln SA\left(cm/\sec^2\right) = C_1 + C_2(M-6) + C_3(M-6)^2 - C_4\ln R - (C_5 - C_4)\max\left(\ln\frac{R}{100}, 0\right) - C_6 R$$

$$R = \sqrt{R_{epi}^2 + C_7^2}$$

Where, M is the local magnitude, R_{epi} is the epicentral distance, and C_i is a constant.

4. PSHA for the Korean Peninsula

4.1 PSHA Results for 8 Sites

In this study, Korean peninsula was divided into three parts, eastern (SOC, ULJ, and BUS), western (SEO, TEJ, and KWJ) and central (WON and KOC) parts. Total number of 8 cities were selected for the target sites. Figure 2 shows the location of the target sites [3].

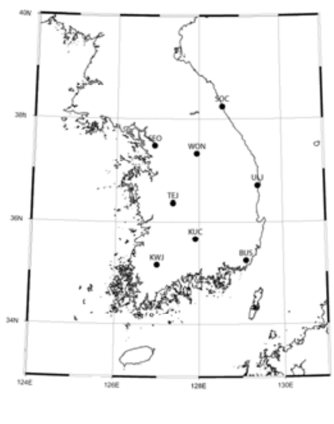
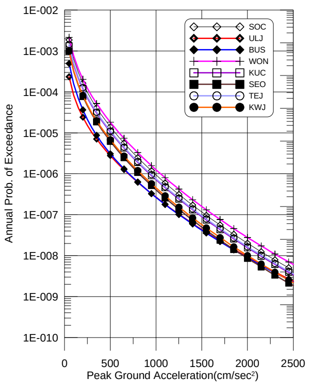


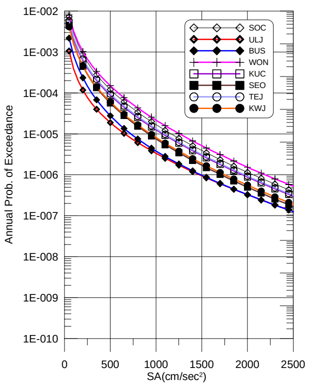
Fig. 2. Site Locations for PSHA

Figure 3 (a) shows the PSHA result for the target site in the case that the PGA is used as a ground motion parameter. As shown in this figure, the seismic hazard of WON is highest among the target cites. In the eastern part, the seismic hazard of SOC is higher than that of the other cities. The hazard of ULJ and BUS is very similar. In the central part, the seismic hazard of WON is higher than that of KUC. In the western part, the seismic hazard of TEJ is higher than that of the other cities. From this figure, it can be found that the trend of the seismic hazard curves for the 8 sites are similar. The PGA value corresponding to p0 = 10-4 is about 250 cm/sec2 for SOC, WON and TEJ based on the seismic source model and the attenuation equation used in this study.

Figure 3 (b) shows the PSHA result for the target sites in the case that the spectral acceleration at 10 Hz is used as a ground motion parameter. The seismic hazard of WON is highest among the target cities. The seismic hazard of the three sites in the western part is almost the same



(a) Peak Ground Acceleration



(b) Spectral Acceleration at 10Hz

Fig. 3. PSHA Results for 8 Sites

4.2 Comparison with Current Seismic Zone

The seismic hazard of a site is usually considered by using the zone factor (Acceleration Factor) in the seismic design guidelines for civil structures. The proposed zone and the zone factor are different according to the guidelines for bridges, buildings and dams.

Table 1 shows the example zone and the zone factor proposed by the seismic design guidelines for bridges. As shown in this table, the zone factor for zone 2 is 0.14, and that for zone 1 is 0.07. This means that the seismic hazard of zone 2 is much higher than that of zone 1. But the seismic hazard of the target cities based on the probabilistic seismic hazard analysis shows the same trend. It means that the difference of the seismic hazard in the low level of earthquake intensity is great, but the difference in the strong earthquake level is small.

The seismic hazard of SOC is almost the same with that of WON where the seismic hazard is the highest among the target cities. But, the design guidelines classified SOC as zone 1.

Table 1. Zone Factors

Zone	Area	Zone Factor
Zone 1	Gangwon-do Jeollanam-do Jeju-do	0.07
Zone 2	Other	0.14

4. Conclusion

The seismic hazard for the eight cities in the Korean peninsula was evaluated by the probabilistic seismic hazard analysis. The peak ground acceleration and the spectral acceleration at 10 Hz were used as the ground motion parameters. The seismic hazard of the target cities in Korea shows little difference.

The seismic risk zone factor proposed in the seismic design guidelines for civil structures, such as bridges and dams, and buildings is very similar to the results of the PSHA except that the seismic hazard of SOC is underestimated. This result is only based on one seismic source model and the attenuation equations proposed by some experts on seismological and earthquake engineering.

To improve the accuracy of the seismic hazard for the Korean peninsula, a further investigation on the seismic source models and the ground motion attenuation equations is required in the future.

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