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Characteristics of Earthquake Ground Motion Attenuation in Korea and Japan

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1. Introduction

The characteristics of a ground motion attenuation in Korea and Japan were estimated by using the earthquake ground motions recorded at the equal distance observation station by KMA, K-NET and KiK-net of Korea and Japan. The ground motion attenuation equations proposed for Korea and Japan were evaluated by comparing the predicted value for the Fukuoka earthquake with the observed records. The predicted values from the attenuation equations show a good agreement with the observed records and each other. It can be concluded from this study that the ground motion attenuation equations can be used for the prediction of strong ground motion attenuation and for an evaluation of the attenuation equations proposed for Korea.

2. Characteristic of Fukuoka Earthquake

2.1 General Description

The West Off Fukuoka Prefecture earthquake occurred in Kyushu, Japan, at 10:53 on March 20, 2005. The earthquake magnitude and the focal depth are 7.0 and 9 km, respectively. The maximum intensity of this earthquake was 6 in the Fukuoka city area.

The ground motion due to this earthquake was propagated to the Korean peninsula. Many people in the south-eastern part of Korea felt the ground shaking, and some people were filled with horror due to the strong shaking of the buildings. Table 1 shows the general characteristics of the Fukuoka earthquake.

Figure 1 shows the recorded peak ground acceleration in Korea and Japan.

Table 1. Characteristics of the Fukuoka Earthquake

Date	Time	Lat.	Lon.	Depth	M_j	M_o	M_w
2005/3/20	10:53:40.32	33.739167	130.17633	9.24	7.0	1.3E+19	6.7

2.2 Source Rupture Mechanism

Referring to the aftershock distribution, it was assumed that the rupture had occurred in a single fault plane which had a length of 26km and a width of 18km [1]. The strike and dip of the fault plane are 122 deg. and 87 deg., respectively.

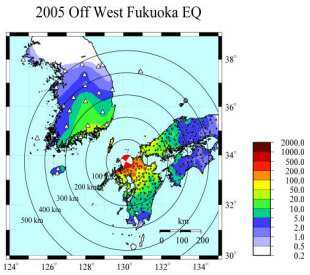
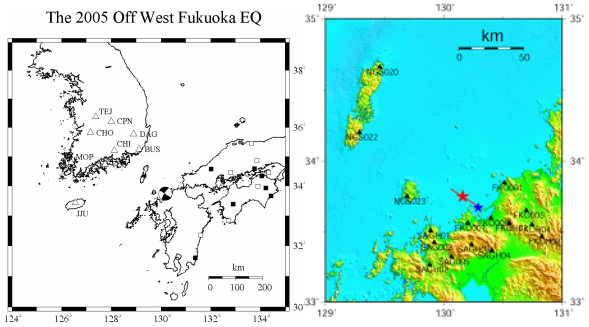


Fig. 1 Peak Ground Acceleration

3. Earthquake Records

The earthquake data used in this study is recorded data by KMA, K-net and KiK-net in Korea and Japan. The K-net and KiK-net are operated by NIED (National Research Institute for Earth Science and Disaster Prevention)

Figure 2 shows the observation point operated by KMA and that by NIED.



(a) Korea (b) Japan

Fig. 2 Observation Point in Korea and Japan

In this study, the peak ground acceleration, acceleration time history and velocity response spectra were compared at an equal distance observation point from the epicenter in both countries. Figure 3 shows the comparison of the acceleration time histories observed in BUS and SMN011. As shown in this figure, the peak ground acceleration in the EW direction is very similar. But the NS and UD component at the Japanese side show a greater value. But, in general, the peak ground acceleration and the spectral velocity for the short period range in the Korean site show greater values.

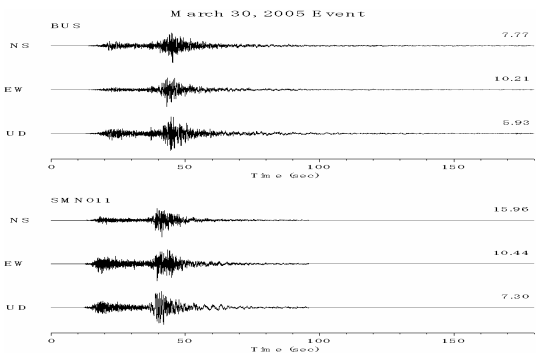


Fig. 3 Comparison of the Recorded Acceleration Time History

4. Ground Motion Attenuation Equations

4.1 Attenuation Equation for Korean Peninsula

The ground motion attenuation equation used in this study is developed by using the recorded earthquake data in Korea [2].

$$\ln(Y(PGA(g))) = C_1 + C_2 * M_w + (C_3 + C_4 * M_w) * a\log(R_{epi} + \exp(C_5)) + C_6 * (M_w - 6.0) * (M_w - 6.0) + C_7 * \ln(\min(R,50)) + C_8(\max(R,50)) \quad (1)$$

$$R = \sqrt{R_{epi}^2 + 9.8^2} \quad (Mw \le 6.5)$$

$$= \sqrt{R_{epi}^2 + 9.8^2 * \exp(2.0 * (-1.25 + 0.227 * Mw))} \quad (Mw > 6.5)$$

where, M_w and R_{epi} denote the earthquake magnitude and the epicentral distance (km), respectively. $C_1 \sim C_8$ are the constants for the attenuation equation.

4.2 Attenuation Equation for Japan Island

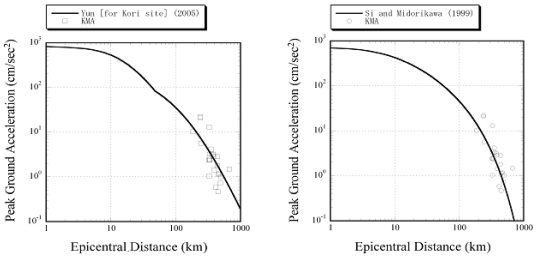
The ground motion attenuation equation developed in Japan is developed by Si et al.. This attenuation equation has been used for the seismic design and seismic safety evaluation of the Japanese nuclear power plant structures and components. This equation was developed by using the observed earthquake data in Japan from 1968 to 1997.

$$\log A = 0.50 M_w + 0.0036 D + d + 0.60 - \log X_{eq} - 0.003 X_{eq} \quad (2)$$

where, A and M_w denote the peak ground acceleration and earthquake magnitude. D and d are the focal depth and the coefficient for the earthquake, respectively. And X_{eq} is the equivalent hypocentral distance.

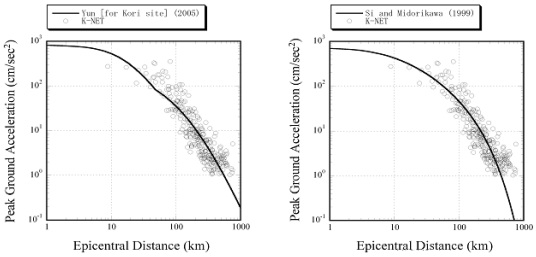
4.2 Comparison of the Predicted Value

Figure 4 and 5 show the comparisons between the recorded data and the predicted value by the ground motion attenuation equations. As shown in these figures, the attenuation equations proposed in Korea and Japan show a good agreement with the recorded data.



(a) By Yun (b) By Si et al.

Fig. 4 Comparison of the Recorded Data and Predicted Value by Attenuation Equation for KMA Data



(a) By Yun (b) By Si et al.

Fig. 5 Comparison of the Recorded Data and Predicted Value by Attenuation Equation for K-Net Data

5. Conclusion

The ground motion attenuation equations proposed in Korea and Japan were estimated by using the Fukuoka earthquake records. From this study, it is concluded that the characteristics of the ground motion attenuation in Korea and Japan are very similar. And the predicted values by the attenuation equations show a good agreement with the recorded data. It means that the attenuation equation developed by using the earthquake data in Korea can be used for the prediction of a strong earthquake.

ACKNOWLEDGEMENT

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REFERENCES

[1] Source Rupture Process and Near-Source Ground Motions of the 2005 West Off Fukuoka Prefecture Earthquake, http://sms.dpri.kyoto-u.ac.jp/k-asano/050320inv_e.html

[2] Yun, K.‐H. and D.‐H. Park, "Development of Site‐Specific Ground‐Motion Attenuation Relations in Korea –Examples for the Nuclear Power Plant sites," The 5th International Workshop on the Fundamental Research for Mitigating Earthquake Hazards, 2005.