Proposal on Attenuation relationship for Peak Horizontal Acceleration of Inland Earthquakes in Northern Vietnam Region

Waseda University	Research Ass.	○ Tran Viet Hung
Waseda University	Fellow	Osamu Kiyomiya

1. Introduction

In order to minimize seismic risk due to inland earthquakes, it is important to predict the occurrence of earthquakes in the future. The prediction of inland earthquakes is conducted by statistical methods based on historical earthquakes, geological data of fault activities, and a long-term seismic hazard for major active faults. An active fault is a fault which has been active in recent geological eras and has the potential to be active also in the future. Vietnam is situated between two greatest seismic belts of Planet: the Mediterranean – Himalayan and Pacific tectonic belts. The strong earthquakes have occurred in Vietnam and magnitude up to 7.0 of Richter's scale. The epicenters of earthquakes are mainly distributed in northern Vietnam where active faults are existing. Thus, the attenuation relationship for peak horizontal acceleration of inland earthquakes in northern Vietnam region will be considered in this study. The shallow earthquakes and inland earthquakes are also adopted in this study (shown in Fig. 1).

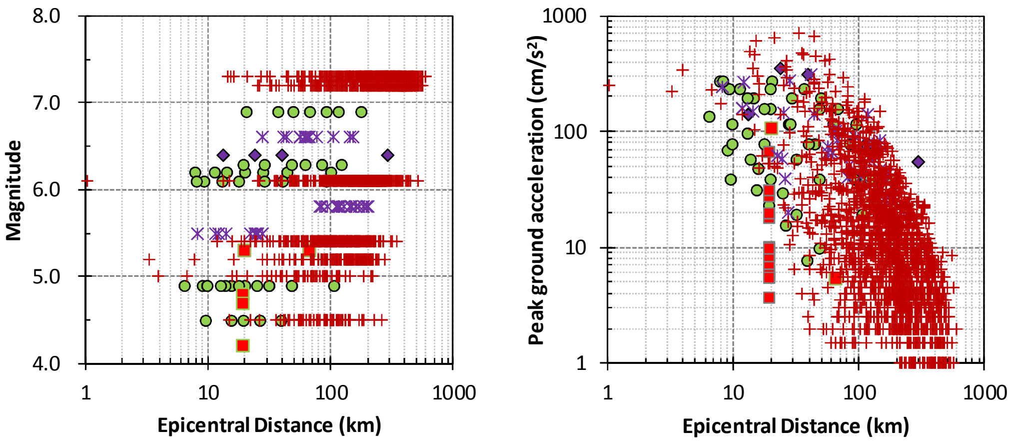

Fig. 1. Distribution of the magnitude, PGA with epicentral distance. (solid points: Vietnam and adjacent areas, "×-type" points: India; "+-type" points: Japan)

2. Attenuation model and regression method

The ground motion attenuation relationships can be obtained by functions of simple parameters which characterize the earthquake source, the propagation path between the earthquake source and the site, and the geologic conditions beneath the site. The general form of the attenuation relation may be considered in this study as follows:

$$\log(A) = f_1(M) + f_2(R, E) + f_3(R, M, E) + f_4(F) + \varepsilon \tag{1}$$

where: A is the peak ground acceleration; $f_1(M)$ is a function of earthquake magnitude; $f_2(R, E)$ is a function of earthquake related to site distance and the tectonic environment; $f_3(R, M, E)$ is a non-separable function of earthquake related to magnitude, distance and tectonic environment; $f_4(F)$ is a function of fault type; and ε is a random variable representing uncertainty in log (A).

The regression model in this research is based on the equation (1) which is the general form of the attenuation relationship. The term $f_4(F)$ is not considered since the focal mechanisms for these earthquakes are not well investigated and considering this term may give various errors to the regression model. The empirical relation by Abrahamson and Letihiser (1989) was derived attenuation relations for vertical and horizontal peak ground acceleration in the U.S. This relation is completed by segregating the data into interplate and intraplate, and then gives small differences for the two

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Address: 〒169-8555, Tokyo, Shinjuku, Okubo 3-4-1; Civil & Environmental Engineering, Waseda University; TEL: 03-5286-3852

source regions. A factor of 0.0011Er and 0.0008Er represents vertical and horizontal peak ground acceleration, respectively, where E is a dummy variable (1 or 0) for interplate or intraplate events, and r is the distance in kilometers from the closest zone of energy release. Since the data set is small in the present study and the tectonic term gives small difference as computed by Abrahamson and Letihiser (1989), the tectonic environment term is neglected for the regression model. This procedure was chosen for Himalayan region in India by Sharma (1998). Sharma (1998) also used a regression model based on the form of the functions which were discussed by Campbell (1985) and preferred for the analysis which includes f_1 (M), f_3 (R, M, E) and f_4 (F), but not the tectonic term. Thus, this procedure is also fit to the lack of data in this study.

3. Results

To see clearly the influence of earthquake data to the results of regression analysis, two options are selected for consideration in this study. Option 1 uses only ground motion data in Vietnam and adjacent areas. Option 2 uses the entire ground motion data including in both India and Japan.

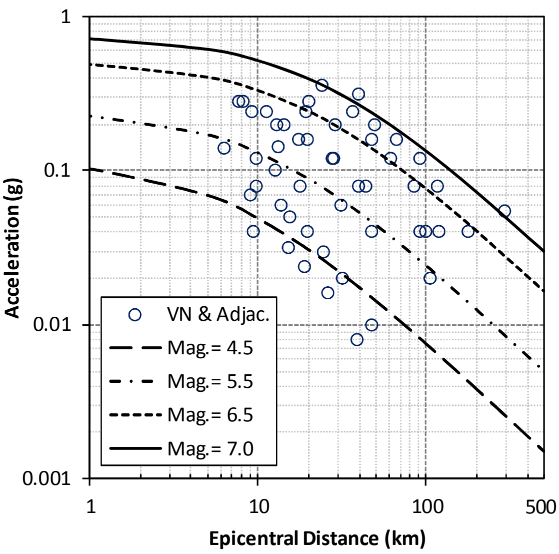
For option 1, the attenuation relationship is computed as follows:

$$\log(PGA) = -2.384 + 0.525\ M - 1.035\ \log(R + e^{0.45\ M}) \tag{2}$$

For option 2, the attenuation relationship is computed as follows:

$$\log(PGA) = -1.7 + 0.558\ M - 1.687\ \log(R + e^{0.45\ M}) \tag{3}$$

where: PGA is the peak ground horizontal acceleration (g), M is the magnitude, and R is the epicentral distance.



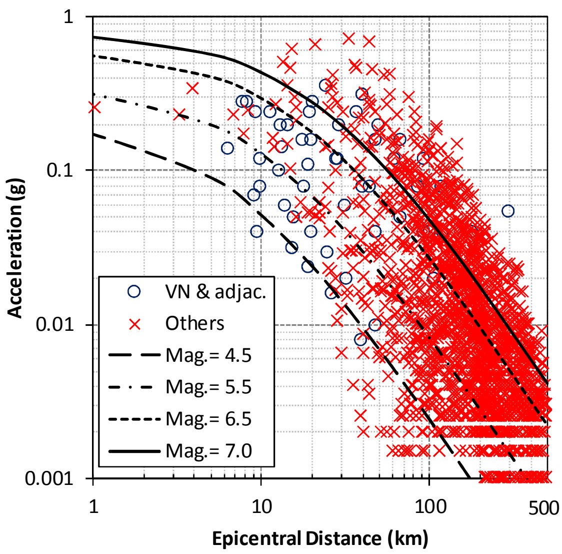


Fig. 2. Attenuation relationship for peak horizontal acceleration (left figure for option 1; right figure for option 2)

4. Conclusion

These attenuation relationships are proposed for inland earthquakes in northern Vietnam region (shown in Fig. 2). The PGA values in these attenuation relations can be used for earthquake resistant design of various infrastructures in Vietnam. However, when more data on strong ground motions will be accumulated in this region, then an update attenuation relationship will be modified.

References

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