CHAPTER VI
CONCLUSIONS AND RECOMMENDATIONS

The selection of ground motion models is essential in seismic hazard analysis. To this end, this research has demonstrated a comprehensive method of assessing the suitability of a ground motion model for a particular region (in this case, Bangkok). Using a process of objective evaluation, a suite of selected models available globally is reviewed and assessed. Although much uncertainty may be associated with attenuation relations, comprehensive evaluation can lead towards estimation of probable ground motions.

6.1 Conclusions

Based on the results of this research, the following conclusions are stated:

1. Suitable attenuation models for Thailand based on the database used in this analysis include the model of Idriss (1993), Sadigh *et al.* (1997) and Campbell (1997) for ground motion in non-subduction region. For subduction region, the model proposed by Crouse (1991) has low RMS value and seems to fit the recorded data quite well.

2. In general, most of the models in active tectonic regions and stable continental regions seem to produce a trend consistent with the collected field records based on the plot of attenuation curves. In stable continental regions, the advantage of using the models is that a broader range of applicability exists. On the other hand, evaluation of models in subduction zones with the field records confined in a narrow distance range may not reflect the actual attenuation rate.

3. In view of the fact that there will be a rare case wherein a region has similar geologic conditions and tectonic attributes to one under study, ground motion models cannot simply be borrowed or adopted to be used in hazard analysis. However, for regions of low seismicity like Thailand, paucity of strong motion data inhibits the development of attenuation model specific for the country. Thus, the methodology adopted herein provides a means to select a suitable attenuation relationship.

4. Based on the investigation done, it should be highlighted that every selected model consistently underestimates the ground motions. Also, no single attenuation relation can ultimately describe the attenuation properties of the region under consideration due to the restrictive range of suitability of each model. Hence, a number of models are selected to represent the low attenuation characteristic of Thailand. The use of regional weak motion data for strong motion prediction is still an open issue. Also, attenuation models yield different estimates of probable ground motions due to the diversity of the predictor variables used in each relation.

5. Having compared two different data sets of ground motion records from old and new digital seismic stations of TMD, the same conclusion has been obtained.

6. Considering the magnitude ranging from 7.0 to 7.5 and distance ranging from 150 to 200 km as the most valuable magnitude-distance ranges to seismic hazard analysis in Bangkok as well as the attenuation models evaluated as most appropriate for the region, the range of estimated peak rock outcrop acceleration in Bangkok would be about 0.7 to 3.5 % g.

7. Results of site response analyses confirm the result of previous studies claiming that the soil profile underlying Bangkok is capable of amplifying earthquake ground motions. The average values of amplification factor of bedrock ground motions corresponding to PRA values of 0.7 and 3.5% g would be about 5.7 and 4.8, respectively. When comparing PGA on soil to PRA, the average amplification factors are in the order of 3.8 and 3.2 times. Therefore, PGA on soil in Bangkok, considering the range of estimated PRA (0.7 to 3.5% g) would be in the range of 2.66 to 11.2% g, respectively.

6.2 Recommendations

The following future activities would further enhance the selection of suitable attenuation model for Thailand and thereby, lead to a better estimation of probable ground motions.

1. Recording instruments should be recalibrated for verification of recorded data.

2. The soil profiles and local site conditions of the recording stations are essential inputs in the assessment. Site-specific shear wave velocity profiles of all seismic stations could be used directly in the attenuation equations. With these data and information on hand, ground motions on rock and soil sites could be classified more accurately.

3. Since the data set used in this research is not adequate to fully resolve the parameters for Next Generation Attenuation (NGA) models, the adequacy of these newly developed relations are not checked. With the new seismic monitoring system in Thailand providing more information about of the occurrence of earthquakes, NGA models can be evaluated against future ground motion records to acquire more information regarding attenuation properties of the region.

4. In order to quantify the dynamic behavior of soft clay deposits in Bangkok, it is expedient to conduct array measurements at various sites in the city. This will lead to a more comprehensive description of the soil profile of the site for use in quantification of amplification factors.

5. More detailed geological and seismological data and information are necessary in order to specify the locations of active faults precisely and to identify potential seismic sources that may significantly contribute to Bangkok's seismic hazard.