CHAPTER 6

Conclusions

Seismic risk assessment and loss estimation are important to the seismic hazard reduction. Knowing the seismic risk and potential losses allows for proper budgetary planning, raising public awareness, assessment and allocation of the necessary manpower for mitigation and disaster management operations, educating the public and professionals on preparedness and mitigation, and prioritization of retrofit applications. There is an urgent need for a methodology that is rapid, realistic, quantitative, and cost effective. This chapter presents the summary of the thesis studied from risk assessment and retrofit prioritization of structures in the seismic risk zones in Chiang Rai Municipality. Three topics are discussed in this chapter: (1) The conclusion of spatial study on the seismic performance of buildings in Chiang Rai Municipality with established earthquake losses scenario and rehabilitation performance, (2) The conclusion on applying fuzzy logic for risk assessment and using an artificial neural network approach for identification of building risk incorporates qualitative and quantitative data which more priority by a learning algorithm from neural network theory and (3) Fuzzy application for prioritization of building damaged after earthquake.

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6.1 Seismic losses estimation and reduction after structural rehabilitation

In this section, the main findings with regard to the spatial study on the seismic performance of buildings in Chiang Rai Municipality to establish an earthquake losses scenario under a magnitude of 5.0 event, and the changes to earthquake losses after upgrading some selected important buildings are presented. To conduct this loss estimation, building data, population distribution and seismicity were spatially collected and GIS-based software was utilized.

The results of the building damage showed that the area that suffered the most was a high density building stock zone. In the seismic scenario, the damage to the buildings was about 400,000 m^2 in every 1 km^2 or 24.79% of the entire buildings' area. The numbers of human losses were about 712 persons during the nighttime and 1,027 persons during the daytime. To simulate loss reduction, some selected buildings, of high importance to the community, comprising of 564 school buildings, 96 hospital buildings, 154 emergency services' buildings and 711 government offices were structurally rehabilitated to the required moderate seismicity standards. The complete damage to those buildings before the rehabilitation was about 225,587.35 m^2, which was reduced to about 115,043.34 m^2 (49%) after rehabilitation. The number of human losses after rehabilitation in the selected important buildings was about 1 person during the nighttime and 86 persons during the daytime. Compared with the numbers of death of 4 persons during the nighttime and 295 persons during daytime before the upgrading, the human losses in the scenario would be reduced by 75% during the nighttime and 70.85% during the daytime. As a result, this information is a good source of help to the government officers to use as a tool to develop the preparedness plan against this kind of disaster happening again.

6.2 Fuzzy Logic and Artificial Neural Networks approach for identification of building risk

Fuzzy risk model approach was used to assess seismic risk of existing structures to help decision makers in prioritizing buildings to retrofit, and for developing plans and strategies for reducing risk. This subjective assessment was undertaken by integrating seismic hazard from PGA (g) value, building vulnerability from the rapid visual screening score, and building occupancy importance score. It takes into account expert linguistics with numerical data, which can be fuzzified with the attachment of different membership function. The evaluation of six buildings as an example were shown for the total risk score expressing building priority need to retrofit, the hospital building is the first priority needed to retrofits with the total risk score of 0.962. Hence, it can be concluded that the proposed approach is a useful method to preparedness and risk mitigation for identifying critical building in the prone area and prioritize their retrofit requirements.

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However, fuzzy logic allows making definite decisions based on imprecise or ambiguous data, where artificial neural network (ANN) tries to incorporate human thinking process to solve problems without mathematically modeling them. Even though both of these methods can be used to solve nonlinear problems, and problems that are not properly specified, they are not related. In contrast to fuzzy logic, artificial neural network tries to apply the thinking process in the human brain to solve problems. Further, artificial neural network includes a learning process that involves learning algorithms and requires training data. Artificial Neural Network there is possibility of evolution and learning whereas fuzzy logic is pure calculative logic taking into its faction the scope of tolerance for imprecision and uncertainty and does not evolve by itself. Thus, the artificial neural network learning techniques can automate this process and reduce development time and cost while improve performance and extracting fuzzy rules from numerical data automatically.

It was found that when use neural network to predict building risk in previous scoring. The selection of appropriate artificial neural network model structure was done by using the random search technique. The appropriate artificial neural network model structure was obtained as the minimum value of Root Mean Squared Error (RMSE). The result gave appropriate architecture of the neural network of damage score is 3-6-1 (Input Layer – Hidden Layer – Output Layer) with the RMSE value equal to 0.0145. The appropriate architecture of the neural network of Total Risk Score is 2-5-1 (Input Layer – Hidden Layer – Output Layer) with the RMSE value equal to 0.0083. With the results of Damage Score and Total Risk Score gave RMSE values nearly 0.0 and so show that the forecast accuracy is highly reliable.

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6.3 Structural repair prioritization of buildings damaged after earthquake using the fuzzy logic model

Earthquakes with high intensity each time cause widespread damage to buildings. However, with the limitation of engineers, equipment and budget, it is impossible to repair all buildings in the same time. In addition, considering factors for making a decision on the need of repair are no longer explicit. Therefore, this research proposes a method to identify critical buildings and prioritize their repairing requirements using fuzzy logic. The evaluated factors were composed of building damaged level, indirect impact and building occupancy. Results of the analysis was found that the buildings having more important, severely damaged and high indirect impacts on the community will be considered with higher priority to repairs, whereas the building which has less total risk index will be considered as non-urgent to repair. As a result in Chapter 5, this information is a good source to help the government officer to use as a tool to develop the preparedness plan for prioritizes their repairing.

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