Each year, disasters caused by earthquakes around the world have devastating effect on people. Most of human casualties in past earthquakes were due to the collapse of buildings, in particular masonry constructions in developing countries. Most of these buildings are categorized as “Non-Engineered Construction”. These are mostly constructed with locally available materials. Furthermore, construction workers are either non-skilled or only semi-skilled and without technical knowledge of seismic construction. Unfortunately, these types of buildings are widely constructed in seismic prone areas in developing countries. The improvement of the safety of non-engineered construction against earthquake is one of the most urgent issue. In the task of the improvement of safety of non-engineered construction, this study proposed retrofitting methods and practical tools for vulnerability and safety evaluation as awareness tool for non-engineered construction in developing countries, these were proven through lessons learned from experiments and practices.

The present thesis composes of five chapters as;

Chapter 1 introduces present study. The background, purpose, research objectives, and past studies with literature survey were presented through observations from field experience.

Chapter 2 describes the investigation of the seismic performance of non-engineered construction of three typical methods of masonry structures in developing countries. Recently, brick and concrete hollow block masonry structures as non-engineered construction become common in earthquake prone area in developing countries.
As the first step, it was necessary to find out the actual behavior during earthquake. Therefore, three series of shaking table tests of masonry construction were carried out to understand the actual behavior until the tested structure collapsed. The typical failure mechanism were demonstrated through three series of shaking table tests. The experiments showed that in plane failure and out-of-plane failure, in particular, masonry gable walls were recognized as vulnerable elements in comparison with other elements. The importance of quality of construction was also demonstrated by experiments.

Chapter 3 presents the retrofitting method that is proposed for non-engineered construction. The proposed retrofitting methods for non-engineered construction in developing countries take into considerations as affordability, feasibility and adaptability for existing situations. The retrofitting methods use wire mesh which is available in local market in these area. Furthermore, the retrofitting method was developed using feasible techniques which is possible to construct without the specific techniques. Also, several studies using shaking table tests of the proposed retrofitting methods demonstrated its effectiveness for masonry structures. The main aim of this study is to save human lives by preventing collapse of buildings. Through the experiments, the superiority of the method was demonstrated. From the movies of the shaking table tests, it can be seen the difference in behaviors between the building with and without reinforcement. The movies would be important as an information and be able to serve as an awareness tool for the people.

Chapter 4 discusses about the challenges for dissemination of earthquake safety construction to the people. It is necessary to make a bridge between engineering and actual field conditions and situations. Workshops and seminars were held in Indonesia after the devastating earthquakes. The possibility of dissemination of the proposed retrofitting method was presented through research in Yogyakarta. Heading towards to implementation, the techniques of retrofitting were improved through vocational workshop in actual practice. At the same time, seminars for residents/house owners were held in Padang. To build an earthquake safer house, collaboration between construction workers and residents/house owners was essential and critical important. This chapter presents lessons-learned on how to improve affordability, feasibility and adaptability of retrofitting.
methods through workshop activities in Indonesia. Moreover, for raising awareness on disaster mitigation, two practical tools for vulnerability and safety evaluation for non-engineered houses were developed in the Philippines.

Tool 1 is "Questionnaire which resident/house owner's self-check for earthquake safety", through this test, house owner is able to understand and realize earthquake risk. Tool 2 is “Software for evaluating the safety and vulnerability of houses” which is able to be conducted by residents/house owners and engineers who are trained. These procedure from Tool 1 to Tool2 are able to connect residents/house owners and engineers, thus making a bridge between them. These tools aim to raise the awareness of the stakeholders, such as the residents/house owners, local engineers, and government. The tools were disseminated through workshops for local government engineers in the Philippines.

Chapter 5 concludes the present study, explaining the approach to improve earthquake safer construction in developing countries that have similar masonry construction.

This study was meant for bridging the gap between experiments and practices, however disaster mitigation is not an easy task, all stakeholders such as government, professionals as architect/engineer, construction workers and residents/house owners should act comprehensive approach to achieve its goal of effective utilization of disaster mitigation.

The condition of non-engineered construction is an infinite diversity of existing situations. From a practical perspective, in considering these conditions, further study which related bonding strength of a variety of wall conditions would be necessary. For example, pull down test which is using actual existing building and static tensile bonding test for variety of condition of walls in further studies. Furthermore, linkage of retrofitting methods and practical tools for vulnerability and safety evaluation would be necessary for widely disseminating in other developing countries with similar problems.

The effort should be continued and made sustainable, because earthquake will always occur.