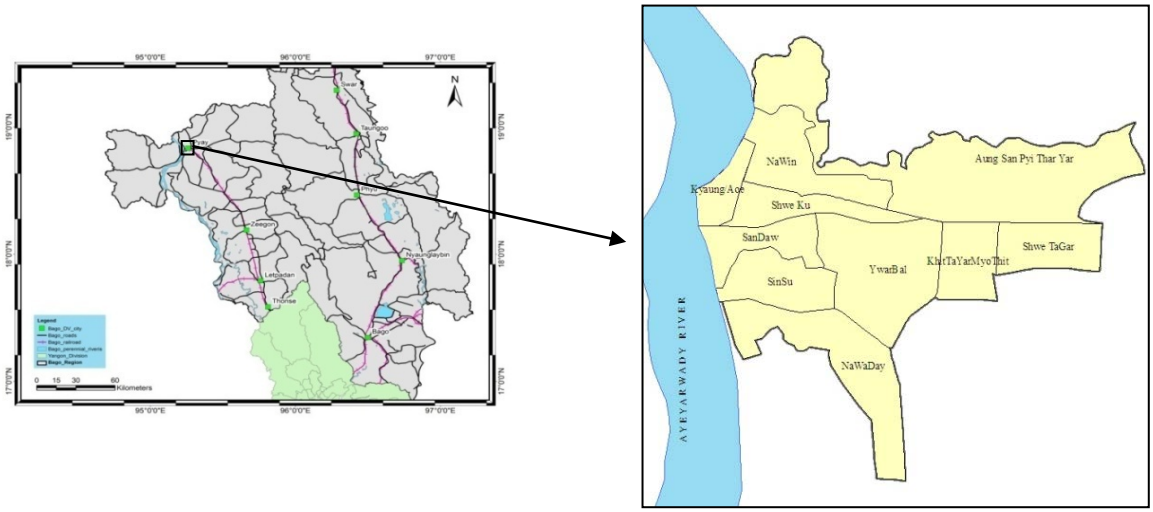
ENHANCING AND DEVELOPING SEISMIC RISK ASSESSMENT FOR PYAY CITY OF MYANMAR



Safer Costal and Urban Communities through Inclusive Disaster Risk Reduction in Myanmar

Project Funded by DIPECHO

December, 2015

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EXECUTIVE SUMMARY

Myanmar is prone to different intensities of earthquakes as it is located on one of the two main prominent earthquake belts of the world with a complex seismotectonic processes (Le Dain et al., 1984). At least nineteen earthquakes of M_s> 7 have occurred in the region. The great Arakan earthquake of 1762 caused extensive changes in the level of the Myanmar (Burma) coast. The 1878 earthquake caused uplift of 6 m on the west coast of Ramree Island, while another island seems to have disappeared.

Among the active fault regions Taungoo – Bago, and Sagaing – Tagaung (Zone V) did not experience any major seismic activity over the past half a century. According to Probabilistic Seismic Hazard Map of Myanmar (2012), there is potential for earthquake along Sagaing Fault. In an around the Pyay area, significant faults are observed and those are well known, Pyay Thrust Fault, West Bago Yoma Fault, Gwegyo Thrust Fault and Sagaing Fault (U Soe Thura Tun, Seismic Hazard Assessment, 2015). Pyay Thrust Fault is located in the western part of Pyay City. If earthquake happens around Pyay City, there may be increasing potential damage to the community and also to the building. There is more population in Pyay area and the city is developing rapidly. Therefore, it is considered essential to take Seismic Hazard Assessment. The purpose of this risk assessment is to acquire the vulnerability of buildings and urban structures so that the preparedness measures and Pyay city development plans can be incorporated accordingly.

Seismic risk assessment was done with field survey of the building inventory and demographic data collection. Seismic hazard assessment work from Myanmar Geo-science Society was referenced in assigning seismic source parameters. Scenario earthquake of Magnitude M7.4 in Padaung Segment of Pyay Thrust Fault is considered for the risk assessment work.

According to the demographic data and building inventory, Pyay city is 304.41 square mile (194,820 acre) wide comprising of 10 wards. Population is around 113,620 with a female and male ratio of more than one in every ward, meaning there are more female than male population. Ywar Bal Ward has the highest number of population among other wards in Pyay. However, Khit Ta Yar Myo Thit Ward, which is industrial zone area, is the most densely populated ward and it is also the highest building density ward. Most of the buildings in Pyay City is brick nogging (Unreinforced Masonry Bearing Walls with Wood Diaphragms

Building - RM Building Type). There are total 31 schools in project area of Pyay city. Among 8 nos. of total hospitals, only one is government and the rest are private hospitals.

HAZUS methodology is applied in seismic risk assessment with maximum probable earthquake scenario of Magnitude 7.4 in Pyay Thrust on Padaung Segment. The assessment results can be found in map format of Direct Earthquake Damage and Economic Losses (shown in Appendix - B). Damages are expressed in three categories; Direct Earthquake Damage, Induced Earthquake Damage, Casualties and Building Related Economic Loss. For Direct Earthquake Damage for buildings are enumerated with four stages; slight, moderate, extensive, and complete damage.

Under M7.4 maximum probable earthquake scenario, it is estimated that about 20,890 buildings, which is over 97% of the total number of buildings in Pyay City will be at least moderately damaged. HAZUS estimated that 17,451 buildings will be damaged beyond repair. On that day of the earthquake, it is estimated that 100% of essential facilities that provide services to public are available for use by the public. Damage stages by ward levels are shown in Appendix – B. For induced earthquake damage, it is mentioned with debris generation. According to analysis, it is estimated that there is no generated debris at the time of the scenario earthquake. Total building related economic loss is estimated to be 1,718,360 millions kyat, 52% of the estimated losses were related to the business interruption of Pyay City. The largest loss was sustained by the residential occupancies which made up over 68% of the total loss.

Seismic risk assessment of Pyay City is performed with the current building inventory and demographic information analyzing based on the maximum probable scenario earthquake. Stakeholders can include the assessment results into their future city development plans. Preparedness measures for essential facilities such as for life saving, fire fighting and transportation can be decided. The results are also useful for communities, understanding the vulnerability of the area where they live in, to understand how to behave in case of an earthquake.

HAZUS tool used in this seismic risk assessment work is the estimation of the damage during the scenario earthquake that is defined by the user. Transportation such as road and streets are not included in this analysis. Stakeholders can think of revising the inventory data covering the current condition of the city.

1. INTRODUCTION

1.1 Background

While the main active tectonics characteristics are the subduction zone of Indian plate and Burma (Myanmar) plate in the West of Myanmar and the collision zone of Indian plate and Eurasia plate in the North West there are several fault lines traversing across the country. The Sagaing fault is the most prominent active fault in Myanmar which extends from north of Lake Indawgyi southward along the Ayeyarwady River north of Mandalay and along the eastern margin of the BagoYoma to the Andaman Sea (Hazard Profile of Myanmar, Sato, 2009). The Deterministic Seismic Hazard Zonation Map of Myanmar developed in 2005, classifies Myanmar into five seismic zones, Zone I (Low Zone), Zone II (Moderate Zone), Zone III (Strong Zone), Zone IV (Severe Zone), and Zone V (Destructive Zone). Tarlay earthquake occurred in Shan State in 2011 highlighted the vulnerability of building stock in Myanmar. Considering the majority of the building stock in both urban and rural areas comprising of non engineered structures such as made of wood, brick, reinforced cement concrete there is an increasing concern on the potential damage to major urban areas such as Yangon, Bago, Taungoo and Sagaing, Pyay, Meikhtila, and Taunggyi along the Sagaing fault.

While Disaster Risk Reduction is a nascent stage, efforts are underway to reduce the vulnerabilities through specific interventions such as multi-hazard risk assessment. In this regard, it has been proposed by UN-HABITAT to carry out earthquake related risk assessments in three cities of Myanmar: Sagaing, Bago, and Taungoo Cities in collaboration with Relief and Resettlement Department, Myanmar Engineering Society, Myanmar Geo-science Society and Myanmar Earthquake Committee with the support from Norway Ministry of Foreign Affairs (NMFA) and ECHO (DIPECHO VIII) since 2012.

Based on the developed risk assessment tools of three cities, Pyay is also considered as the priority for next Earthquake Risk Assessment (DIPECHO IX) project. Pyay earthquake that happened on 24th August 1858 causes damages of houses and Pagodas at Pyay City. Pyay have a population of more than 113620 people as per survey results (2015) and the city is developing rapidly with the construction of mid-rise buildings. Therefore, it is decided to make earthquake risk assessment in Pyay City. The results will be in useful in developing comprehensive risk reduction programs addressing the specific vulnerabilities in the city. The

risk assessment will guide to future development in the cities along with UN-Habitat's Myanmar Comprehensive Disaster Risk Reduction Programme and also with broader DRR activities and those of Government.

1.2 Objectives and Scope of the Project

The main intension of the project is to develop the knowledge and resources that can be used in seismic risks mitigation decisions. The specific objectives are as follows:

1. To acquire the vulnerability of buildings and urban structures of Pyay City
2. To carry out seismic risk assessment
3. To incorporate the results into preparedness programmes and urban development plans
4. To apply risk assessment and prevention programmes for further development of Pyay City

Using Seismic Hazard Assessment produced by Myanmar Geo-science Society, seismic vulnerability analysis was done. Socio-economic profiling and inventory of critical infrastructures of Pyay City is undertaken by surveying in the field. City level seismic risk assessment of building structures are evaluated for different earthquake scenarios for Pyay City. Using the analysis data of representative buildings and the Base maps, Seismic Risk Map is prepared. Chapter 1 of this report will be introduction parts enumerating objectives and scope of the project. Chapter 2 describes the overall framework of the methodology. Chapter 3 discusses inventory data, including demographic, building data attributes required to perform damage and loss estimation. HAZUS analysis and results are described in Chapter 4. Chapter 5 explains the discussions and recommendations of the results.

2. METHODOLOGY

The HAZUS methodology and Earthquake Model is used for loss estimation in this project. Analysis is performed with two portions: identification of element of risk and estimation of vulnerability, and assessment of seismic risk.

Firstly, element of risk are identified and vulnerability are estimated for the current condition of Pyay City. All aspects of the demographic aspects and built environment, such as locations, numbers, occupancies and square footage of the buildings are prepared in a formatted database using GIS based technologies. These inventories are collected by field surveying in the project area and are used as input data in HAZUS loss estimation. The methodology estimates the several levels of damage based on the level of inventory data availability, ground motion and ground failure of Earthquake Scenario for the analysis.

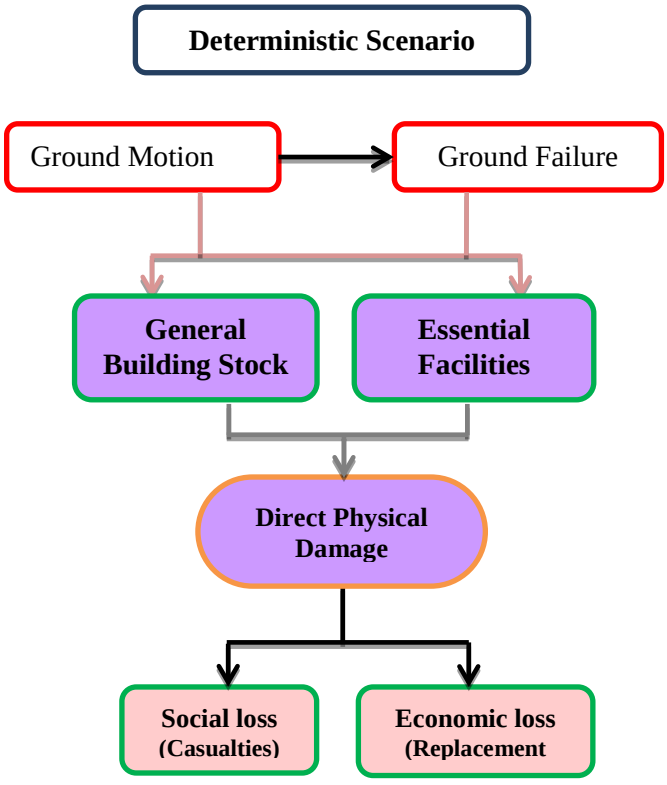

Figure (2.1) Flowchart of the Earthquake Loss Estimation Methodology adopted by HAZUS

For assessment of seismic risk, seismic ground motion demand is considered. Normally, three options are available for computations of seismic ground motion demand: (1) deterministic calculation, (2) probabilistic maps, and (3) user-supplied maps (HAZUS MH MR 5 Technical Manual). Deterministic calculation will be used by choosing maximum probable scenario

earthquake magnitude and location that is relevant for Pyay City. Maximum probable scenario earthquakes are taken from past research work by Myanmar Geo-science Society. Figure (2.1) shows the contents of the HAZUS methodology used for this project.