ENHANCING AND DEVELOPING SEISMIC RISK ASSESSMENT FOR TAUNGOO CITY OF MYANMAR



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Safer Costal and Urban Communities through Inclusive Disaster Risk Reduction in Myanmar Project Funded by DIPECHO

December, 2015

Background

Developing countries typically suffer far greater than developed countries as a result of earthquakes. Poor socioeconomic conditions often lead to poorly constructed homes that are vulnerable to damage during earthquakes. Our country, Myanmar is a developing country and one of the multi-hazard prone areas around the world according to its geographical situation. Myanmar lies on one of the world's two main earthquake belts and many of the urban centers are along the Sagaing fault running North –South of the country. The Sagaing fault is the most prominent active fault in Myanmar which extends from north of Lake Indawgyi southward along the Ayeyarwaddy River north of Mandalay and along the eastern margin of the BagoYoma to the Andaman Sea (Hazard Profile of Myanmar, Sato, 2009). According to a recent study, on relocation of historical earthquakes since 1918 along the Sagiang Fault, there exist two seismic gaps: one between $19.2^{\circ}N$ and $21.5^{\circ}N$ in central Myanmar, and another south of $16.6^{\circ}N$ in the Andaman Sea. Considering the length of the first seismic gap (~260 km), a future earthquake of up to M ~7.9 is expected to occur in central Myanmar (Nobuo Hurukawa and PhyoMaungMaung, 2011).

Rapid and unplanned urbanization in Myanmar is increasing the vulnerability of future disasters especially for earthquake. Besides, over the past three decades, urbanization in Myanmar has been rapidly increasing. In most cities throughout the country, this urbanization took place minimal consideration of building codes, sound construction, and urban planning practices. As a result, many of Myanmar's urban cities developed in the proximity of active seismic sources and are at risk of experiencing major earthquake events. Seismic risk cannot be eliminated, but it can be effectively analyzed and possibly reduced by using proper tools and models to produce reliable and meaningful estimates of the seismic risk facing a community, and exposure.

Considering the majority of the building stock in both urban and rural areas comprising of non-engineered structures such as made of Timber, Brick Nogging, Brick Masonry and reinforced Reinforced Concrete, there is an increasing concern on the potential damage to urban areas such as Yangon, Bago, Taungoo and Sagaing, Meikhtila, Taunggyi along the Sagaing fault. Therefore, this paper tends to estimate the damage and casualties, to develop seismic risk and related assessment of building structures (Public, Private, and Pagodas) for the maximum estimated seismic scenarios in Taungoo City. The study findings will lead to develop comprehensive risk reduction programs addressing the specific vulnerabilities as well as guide the future development in the cities along with UN-Habitat's Myanmar Comprehensive Disaster Risk Reduction Programme and also with broader DRR-WG activities and those of Government. Methodology

HAZUS methodology for earthquake loss estimation model is used for risk assessment tool. The framework of the methodology includes Potential Earth Science Hazard (PESH), Direct Physical Damage, Induced Physical Damage, Direct Economic/Social Loss and Indirect Economic Loss. Inventory for general building stock and essential facilities are used as input data. Direct damage data of building and essential facilities, casualties, and economic losses are just developed as output result of HAZUS analysis because of limited resources. The earthquake loss estimation methodology can develop the preliminary estimation of damages to prepare before disaster situation and to plan and stimulate efforts how to reduce probable risk from earthquake. The flow chart of HAZUS methodology is shown in Fig (1).



Figure (1) Flowchart of the Earthquake Loss Estimation Methodology adopted by HAZUS

Taungoo City

Taungoo is a city in the Bago Region of Myanmar, 220 km form Yangon, towards the north-eastern end of the division, with mountain ranges to the east and west. The main industry is in forestry products, with teak and other hardTimbers extracted from the mountains. The city is known for its areca palms, to the extent that a Burmese proverb for unexpected good fortunes is equated to a "betel lover winning a trip to Taungoo". The location map of Taungoo City is shown in figure (2).



Figure (2) Location Map of the Study Area

The city is famous in Burmese history for the Taungoo Dynastry which ruled the country for over 200 years between the 16th and 18th centuries. Taungoo was the capital of Burma in 1510-1539 and 1551-1552. Taungoo city is mainly composed of 23 wards and there are over 17 thousand households in the region with a total estimated population of over 1 million. Significant and famous places of Taungoo city is shown in figure (3)



Figure (3) Significant and Famous Places in Taungoo City

Taungoo City lies among the Sagaing Fault, Kyaukkyan Fault and Papuan Fault. Sagaing Fault is situated in the west of the study area, Kyaukkyan Fault and Papun Fault are in the east. The earthquake risk of the Taungoo City is mainly caused by the movement along the Sagaing Fault which is a right-lateral strike-slip fault that runs north-south along the eastern flank of Bago Yoma. High magnitude events indicate that the Sagaing Fault is the principle source of seismic hazards in Myanmar. Taungoo City is the earthquake prone city in study area.

The most significant event is the magnitude 7.3, August 8, 1929 Swa earthquake. This earthquake caused severe damage in Taungoo Township, e.g. the railway was bent and the bridges and culverts caused damage and the loaded trucks were turned upside down. Another one is the Bago earthquake that struck on May 5, 1930 with the magnitude of 7.3. This event caused 500 deaths in Bago and several buildings damaged. Phyu earthquake occurred on December 3, 1930 with the magnitude of 7.3. It destroyed many houses and caused 30 casualities in Phyu. Figure (4) below shows previous past earthquakes around Taungoo City and distribution of past earthquakes in Myanmar.



Figure (4) Epicentral distribution of the previous earthquakes with magnitude ≥ 6 , happened around Taungoo Region and Distribution of Earthquakes 1900-2009

Livelihood in Taungoo

As per demographic data, Yakhinesu Naypukhone ward has the highest population whereas South Pan Pae Tan ward has the lowest one. Among all other data in the livelihood, the highest number of building, population, and households are in Yakhinesu Naypukhone ward. Tat Myae ward is the second populated area in Taungoo in which Min Kyee Nyo is in the third place. Yakhinesu Naypukone (10478), Tat Myae (8280), and Minn Kyee Nyo (7526) have got the highest population among any other wards in Taungoo whereas South Pan Pae Tan (953) have got the lowest population. Population is just above 9% of highest population in Shan Tan and Lann Ma Kyae wards (Figure A-1). The highest population density (population per area-km2) among any other wards is in Zaung Chan Taung. And Kwae Zay is the second highest in population density. (Figure A-2).

As Yakhinesu Naypukone ward has got the highest population amongst any other wards, the total number of children/youngster under 18 is also the highest. Younger population in South Pan Pae Tan (773), Lann Ma Kyae(799) and Shan Tan (802) are the lowest (Figure A-3). Ngwe Hlan Oae Kone (2001), Myo Gyi (2023), Tat Myae (2486), and Minn Kyee Nyo (2881) are the second highest number of aged above 18.(Figure A-4). In female to male ratio, Kan Taw, Zaung Chan Taung, Lann Ma Kyae, Kyat Tae, South Pan Pae Tan and North Pan Pae Tan are the highest in Taungoo.(Figure A-5). The number of households in Yakhinesu Naypukone (2250) and Tat Myae (1748) are the largest as population distribution. The wider the ward is, the higher the household is (Figure A-6). Among all wards, South Pan Pae Tan and Shan Tan wards have the lowest building counts of under 200 (Figure A-7). Also Zay Taung, Kwae Zay and Kyat Tae wards have got the highest building density in any other wards in Taungoo (Figure A-8).

Inventory Data for general building stock and essential facilities

Inventory data includes general building stock, essential facilities, and its related replacement cost. The former two inventory data deal with direct damage data whereas the latter is related to economic loss. Three groups of wards in Taungoo are classified depending on levels of economic condition; rich, medium, and poor, to take rapid visual screening survey. The main idea of dividing three groups is to get the different types of building and its use because of the interdependency between building type and income of the family. There are mainly five structure types which can be found in Taungoo. These are Timber, Brick Nogging, Reinforced Concrete, Brick Masonry, and Mixed-use. Timber building types are the most common type in Taungoo.







Brick Nogging Building (RM1L)



Mixed- Use Building (MH)





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