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A STRATEGIC WAY FOR PROMOTING IMPROVED SEISMIC RESISTANT TECHNIQUES TO INDONESIAN BUILDERS

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ABSTRACT

Indonesia is located in a seismically prone area. During the Aceh 2004, Yogyakarta 2006, Padang 2009 earthquakes, many casualties were caused by the collapse of buildings. Due to lack of awareness, knowledge and skills, many of these buildings, particularly non-engineered houses, were rebuilt using non-seismic resistant techniques as used previously. In cooperation with the World Housing Encyclopedia (WHE), a strategic way for promoting improved seismic resistant construction to Indonesian builders has been implemented. Architectural and Civil Engineering students are involved. A special tutorial is conducted periodically by seismic engineering experts to enable these students to learn practical seismic resistant techniques for designing and constructing single to two storey dwellings as well as multi storey reinforced concrete buildings. During their studies they are assigned to promote these techniques to the community at large and to builders in particular. A student e-network is set up to enable them to exchange ideas and encourage each other. The first phase of this effort is reported in this paper.

Key words: *improved seismic resistant techniques, seismic prone area, non-engineered houses, single to two storey dwellings, reinforced concrete buildings.*

Introduction

Most parts of Indonesia are located within a region of intense seismic activity known as the Pacific Ring of Fire. In the last decade, Indonesia has been subject to three major earthquakes: the 2004 Indian Ocean Earthquake of Richter magnitude 9.0; a magnitude 6.3 earthquake that devastated the Yogyakarta area in 2006; and just last September 2009, the magnitude 7.3 earthquake that damaged much of Padang and surrounding districts. All of these quakes resulted in the collapse of many masonry and concrete buildings along with a large number of casualties.

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Since 1970 Indonesia has had building codes and standards to guide architects and structural engineers in designing seismic resistant buildings. Static analysis procedures have been applied for buildings less than 40 metres in height where the seismic force is determined by multiplying the structural mass at a particular level by the earthquake acceleration coefficient determined from the Code (The Indonesian Loading Code, NI-18 1970). For buildings higher than 40 metres, dynamic analysis has been used and has typically been done by specialists. No further guidance regarding the dynamic analysis was available and the code itself was very brief.

In 1976, the New Zealand Public Works, in partnership with Beca Carter and their Indonesian counterparts (Public Works officials, academicians, practitioners), were commissioned to undertake a national earthquake engineering study in Indonesia in order to prepare Earthquake Resistance Design Guidelines for Houses and Buildings. The first and second drafts were issued in 1981 and 1983 respectively. The official design guidelines were subsequently published in 1987. The Indonesian region was divided into 6 seismic zones with Zone 1 having the highest seismic risk and Zone 6 having the lowest risk. Two types of soil conditions were considered: soft and hard. Three types of analysis were adopted: equivalent static analysis, response spectrum analysis and numerical integration time history analysis. Static analysis was deemed applicable for buildings less than 40 metres. The total base shear forces were determined by multiplying the total building mass to the importance factor, the structural type factor and the seismic coefficient determined from the Code (SNI 03-1726-1987). The total base shear was then distributed into each level in accordance to the displacement shape of the building.

The 1987 Earthquake Resistant Design Guidelines has been superseded by the 2002 Earthquake Resistant Design Standard (SNI-1726-2002). This Standard makes reference to UBC-1997. Consistent with the previous guidelines, the Indonesian region was again divided into 6 seismic zones but with Zone 1 having the lowest seismic risks and Zone 6 having the highest risk. Three types of soil condition were considered: soft soil, medium soil and hard soil. Recently, as a result of the major earthquakes that have struck Indonesia, a new committee was appointed to prepare a new Earthquake Resistant Design Standard referring to ASCE 7-05, IBC-2006 and IBC-2009. It is anticipated that it will be published in year 2010.

Most residential buildings of one or two storeys in urban and rural areas are being built using locally sourced masonry such as red clay bricks, concrete blocks or lightweight concrete blocks. There are no provisions in the 2002 Earthquake Resistant Design Standard for these type of buildings. A specific code for seismic detailing of masonry structures is not available at this time. However, “Examples of Earthquake Resistant Building Analysis in accordance with the Indonesian Earthquake Resistant Design Guidelines for Building” was published by the Public Works Department in 1982 and has been deemed adequate for the design of masonry buildings will not collapse during severe earthquake.

In a developing country like Indonesia the availability of codes and standards like those described above, is not necessarily followed by an awareness and understanding by its citizens regarding seismic resistant construction as well as its importance in striving to protect lives and buildings. Structural failures as a result of earthquakes have been extensively described in text books, mass media and guidelines but severe damage continues to occur.

Buildings consisting of a combination of retail and residential activities are nowadays very common in Indonesia, both in urban and rural areas. These buildings usually consist of between two to four storeys with the lowest floor reserved for business purposes and the upper floors used as domestic dwellings. For structural analysis, it is a common practice to model this type of building as open frames. However, during construction, brick walls are often installed as infill partitions which act as dividers between one particular shop and its neighboring unit. In some cases an owner may own several units, and elect to connect the lowest floor of these units by removing their dividing walls. This reduces the strength and stiffness available at the lowest level and may lead to a soft storey during an earthquake. Structural engineers should be able to anticipate this and undertake measures to avoid this. Local authorities should also ensure that owners who wish to connect the lowest level of these units by removing their dividing walls provide adequate remedial strengthening.

a. Shop houses suffered severe damage after Aceh earthquake 2004

b. Shop houses suffered severe damage after Yogyakarta earthquake 2006

c. Shop houses suffered severe damage after Padang earthquake 2009

Figure 1. Typical damages at shop houses due to soft storey mechanism

In many major cities throughout Indonesia there are still a number of old Dutch style buildings, which were constructed using unreinforced masonry walls. This type of buildings is no longer allowed to be built in seismically prone areas and existing heritage buildings of this type need to be strengthened. However, as there is still no mandatory regulation many buildings of this kind suffered severe damage during earthquakes. Figure 2 shows unreinforced masonry buildings which suffered major damage during the latest (2009) Padang earthquake.

a. Before Padang Earthquake 2009

b. After Padang Earthquake 2009

c. Before Padang Earthquake 2009

d. After Padang Earthquake 2009

Figure 2. URM buildings suffered severe damage

Traditional houses used to be built with light building materials, such as timber and bamboo mats. These types of houses normally survive strong earthquakes. However, through economic growth and modernization, many rural inhabitants tend to perceive houses with masonry walls, instead of bamboo mats, as a status symbol of successful people. Bricks are heavy building materials and if a building is not designed and constructed properly it may suffer from major damage during strong ground shaking as illustrated in Figure 3.

a. After Bengkulu earthquake 2000

b. After Tasikmalaya earthquake 2009

Figure 3 Typical houses built with unreinforced masonry walls suffered major damage during Bengkulu and Tasikmalaya earthquakes.

In order to predict the reoccurrence of severe damage on typically vulnerable buildings during major earthquakes a strategic plan needs to be implemented. The best seismic resistant techniques, including local knowledge about building seismic resistant traditional houses, need to be publicised among ordinary citizens and especially to builders as well as architecture and civil engineering students. Since this younger generation will be responsible in reducing the number of casualties and building damage during earthquakes in the future, they need to be equipped with the proper knowledge and skills.

Strategic Plans

The basic level of understanding regarding seismic resistant techniques among engineers and government officials depends mainly on what they have learnt while studying at university. The dissemination of new codes and standards is not as effective in enhancing their understanding of how buildings respond to earthquakes, especially those who are practicing outside Jakarta and other big cities in Java.

It is essential to encourage civil engineering and architectural students to develop an interest, understanding and expertise in seismic engineering while they are studying at university. An appropriate strategic plan, as shown in Figure 4, needs to be implemented. It is essential to equip these students with electronic learning facilities which enable them to have an access to high quality learning materials, to carry out independent learning activities regarding seismic engineering practices and to exchange information and experience with experts and their peers.

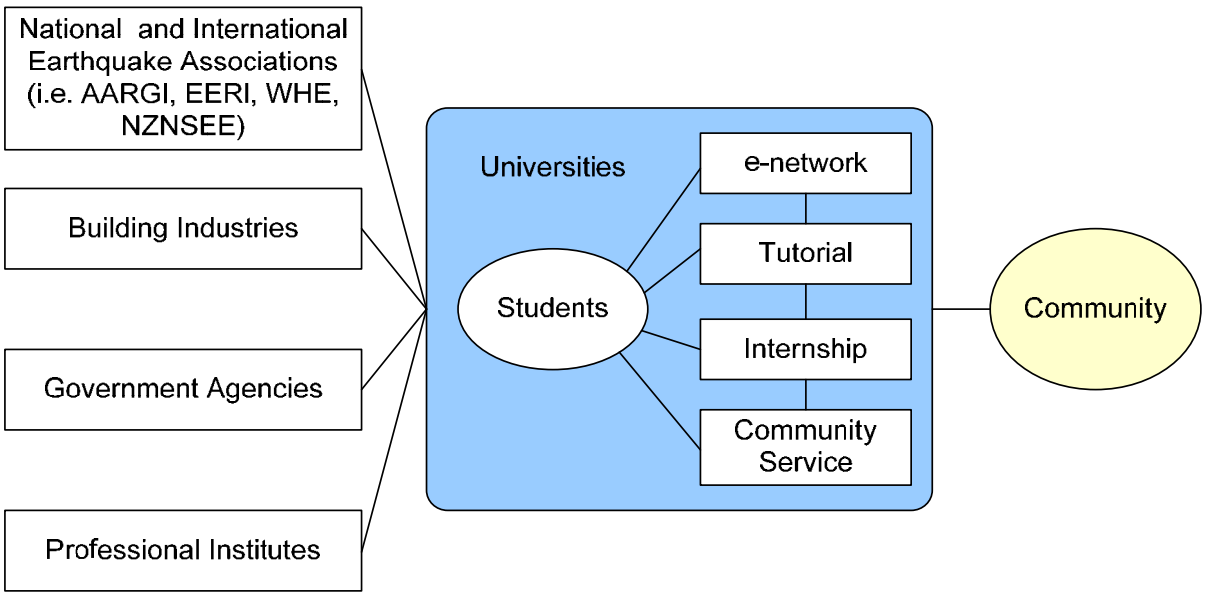

Figure 4. Strategic Plan Diagram

As can be seen in the Strategic Plan diagram, it is hoped that National and International earthquake associations, building construction industries, government agencies, and professional institutes will support the implementation of this plan by providing high quality learning or

tutorial materials, internships and/or community service opportunities for university students. For this purpose, these civil engineering and architectural students are directed to the website. This was developed using an open source program called tikiwiki (www.tikiwiki.org). The front page of the www.indo-housingpedia website is shown in Figure 5.

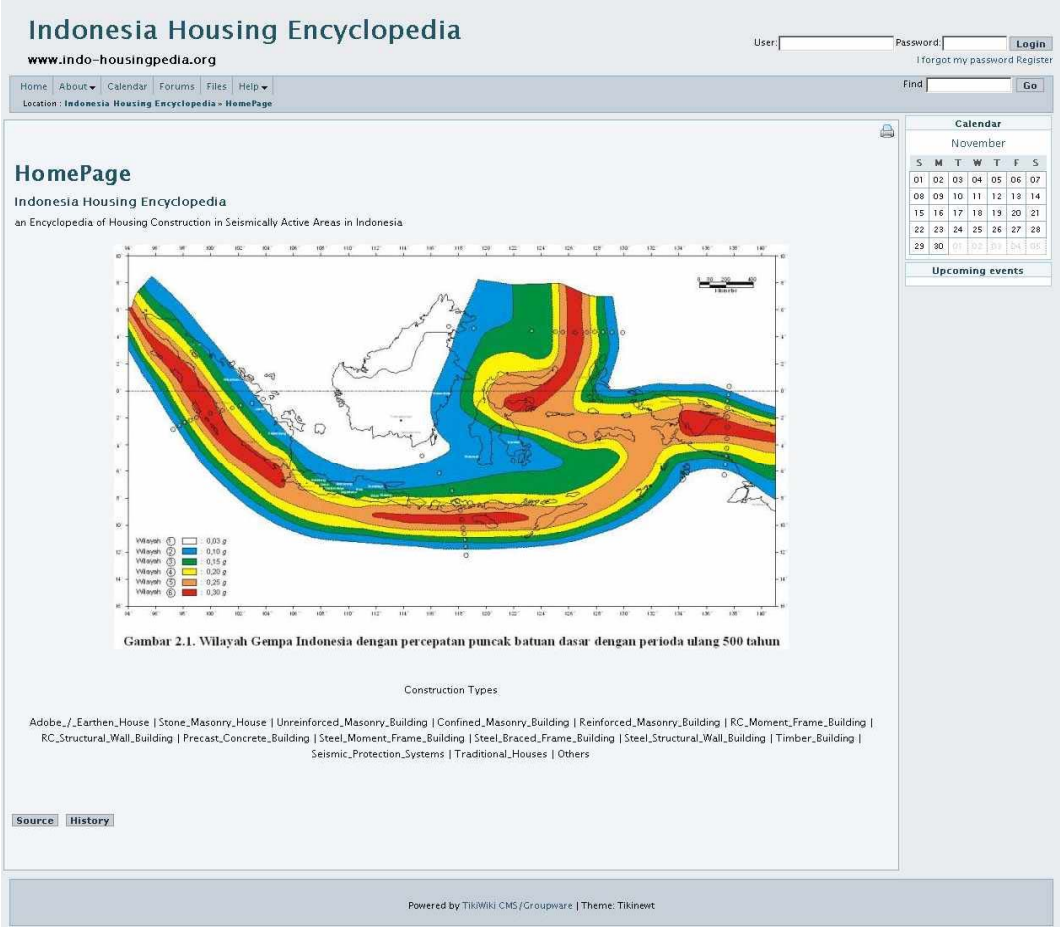

Figure 5. The front page of the indo-housingpedia website

Using this website, university students are able to share their learning experience and communicate with their peers throughout the country. It is expected that in the future they will make use of the website to learn about the latest codes and standards. It is hoped that this initiative will also raise national awareness and encourage responsibility towards the consequences of neglecting appropriate seismic resistant techniques nationwide. Finally, all these efforts are expected to benefit the community.

Implementation

At the first phase of this endeavour, lecturers and students from three universities are involved: Trisakti University, Jakarta; Parahyangan University, Bandung (West Java); and Petra Christian University, Surabaya (East Java). By using the website, www.indo-housingpedia.org, civil engineering and architectural students from the above universities will be able to:

a. Learn from the included tutorial regarding the best seismic resistant techniques taught by Indonesia and foreign experts (both researchers and practitioners);
b. Report their experiences after carrying out practical work, internships and/or community service including post-earthquake surveys;
c. Discuss their experiences and ideas with their fellow students and/or lecturers;
d. Submit research based articles on seismic engineering;
e. Study and discuss the latest codes and standards; and
f. Join student competitions in finding best solutions for protecting buildings in seismically prone areas. The solutions must be most suitable to the conditions in Indonesia.

During their studies they are also encouraged to teach these techniques to the community at large and to builders in particular. The students are able to do this through their internships, practical works, and community services for a certain period of time during their studies.

To ensure the quality and consistency of published material, an editorial board has been established. The editors are responsible for the review of submitted articles and reports from registered members as well as comments from participants of discussion forums. Lecturers and students from participating universities are afforded the privilege as registered members. Only registered members are allowed to submit articles or reports. Ordinary visitors of the website are treated as guests and can only read the available materials.

At part of the next phase, more civil engineering and architectural lecturers and students from various universities as well as staff members of building construction and consulting firms as well as members of related professional institutes will be invited to join this network. Interested firms and organizations are also invited to sponsor this initiative by giving financial support and putting their logos in banners on the front page of the website.

Conclusion and Suggestion

A strategic way for promoting the best seismic techniques as well as implementing e-learning facilities has been introduced. It is primarily aimed at current and future university students, who are more familiar with digital media than their predecessors. This new generation is expected to be the agents of change who are able to influence builders and citizens of Indonesia to be more aware of the consequences of neglecting best seismically resistant techniques. Moreover, the website is also expected to be able to serve as e-learning resources for architects and civil engineers in updating their knowledge regarding the latest issued codes, standards, as well as research results.

The initial stage of implementation of this endeavour has been started. Students and lecturers from three universities have been involved. The availability of a specially designed and dedicated website is hoped will enable students to easily access important information regarding seismic resistant techniques as well as to share their experiences with their fellow students throughout Indonesia and even with fellow students from other countries. In the near future more students and lecturers of other universities, as well as practitioners throughout Indonesia will join and make use this e-learning facility.

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