Key Features of Position Paper on Issues Related to Earthquake

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1.0 INTRODUCTION

The safety of building structures in Malaysia affected by seismic waves emanating from earthquakes locally (Figure 1), and in and close to Indonesia (Figure 2), has always been of concern to the general public. The issue has been brought back under the spotlight after the 26 December 2004 earthquake which triggered the tsunami that claimed 68 Malaysian lives. Although there were no other fatalities among occupants staying in nearby buildings in that incident, in the past, there were reported cases of buildings swaying and structural and non-structural defects in the form of cracks. In general, these occupants have expressed fear for their safety.

A position paper committee was established in April 2005 to look into these issues and has subsequently arrived at a common stance on proposals for mitigation policy and guides on earthquake safety. The main issues and key features of the paper are as reported.

2.0 THE ISSUES

Like in any other young and not-so-developed discipline of engineering field in this country, the basic underlying issues here are that there is insufficient earthquake related data and that existing Building By-laws or codes of practices do not have the legislations and guidelines to address the effects of earthquake-induced vibration to building structures. Hence, there is a lack of sustainable solutions to overcome safety concerns. This paper aims to firstly address these basic underlying issues and determining that the continuation and further development in this field could be possible. The success depends greatly also on the courses of actions taken by various players and stakeholders in the local engineering industry.

3.0 RECOMMENDATIONS

The recommended measures on these issues are presented as short and long term course of actions.

3.1 Recommended short term measures

3.1.1 Need for more seismic monitoring stations in Malaysia

A total of 12 strong motion seismic monitoring stations were set up in Malaysia in 2004. Five were installed in Peninsular Malaysia, while the remaining seven were installed in East Malaysia. Since such data is important for design, there is an immediate need to increase the number of seismic monitoring stations in the country. The current five numbers of seismic monitoring stations in peninsular Malaysia is recommended to be increased to at least one station per state so that sufficient data could be gathered for better decision making in the future.

3.1.2 Exhort for the setting up of instrumentation for measuring the acceleration response of buildings

Acceleration measurement devices are needed to be installed on a building to obtain the acceleration at different storey height. It is recommended in the ACI code that such devices shall be installed on at least three positions of highrise structures, i.e. at the base, at mid-level, and at the top/roof level, in order to obtain accurate and reliable acceleration readings of the building response. Such data will be extremely useful for a better understanding of structural response in the future.

3.1.3 Undertake seismic vulnerability studies of existing important buildings or structures, particularly in high risk areas

Vulnerability studies are recommended to be carried out to mitigate risk.

Attention needs to be given to the geometry and configuration of a structure, the continuity of load path, the uniformity of inter-storey stiffness and strength. The existing condition of the structure and non-structural components are of important factors, including heavy architectural cladding on the façade of the buildings.

3.1.4 Review of current engineering design and construction standards and practices

One of the immediate tasks that can be carried out by the IEM and jointly with other professional bodies is to review the current practices and design standards on buildings in the country. This is essential as the current standards do not address the possible vibration forces, principally due to earthquake. Once reviewed, comments and / or suggestions raised should be tabled to the proper authority for further action, such as to draft and incorporate new earthquake design guidelines into the current national standards.

3.1.5 Need for the design of high-rise buildings in West Malaysia to cater for long period vibration

It was also observed that the earthquake characteristic that has affected the structures in West Malaysia was of long period. Due to the long distance traversed by the seismic wave (or far field effect), the short period vibration characteristic has been filtered out. When a fault ruptures, seismic waves are propagated in all directions, causing the ground to vibrate at frequencies ranging from about 0.1 to 30 Hertz. Buildings vibrate as a consequence of ground shaking; damage takes place if the building cannot withstand these vibrations.

Compression and shear waves mainly cause high frequency (>1 Hertz) vibrations which are more efficient then low frequency waves in causing low buildings to vibrate. Rayleigh and Love waves mainly cause low frequency vibrations which are more efficient than high frequency waves in causing tall buildings to vibrate. Because amplitudes of low frequency vibrations decrease less rapidly than high frequency vibrations as distance from the fault increases, tall buildings located at relatively great distances (60 miles) from a fault are sometimes damaged (Hays, 1981).

The recommended height of buildings to be checked for long period vibration is buildings of seven storeys and above. This range of building's height is found to be particularly vulnerable to effects of long period earthquake vibration.

A study on soil samples of five cities in the West coast of Peninsular Malaysia by University Technology Malaysia (UTM) has shown that the average local soil amplification ranges from 1.4 to 3.6.

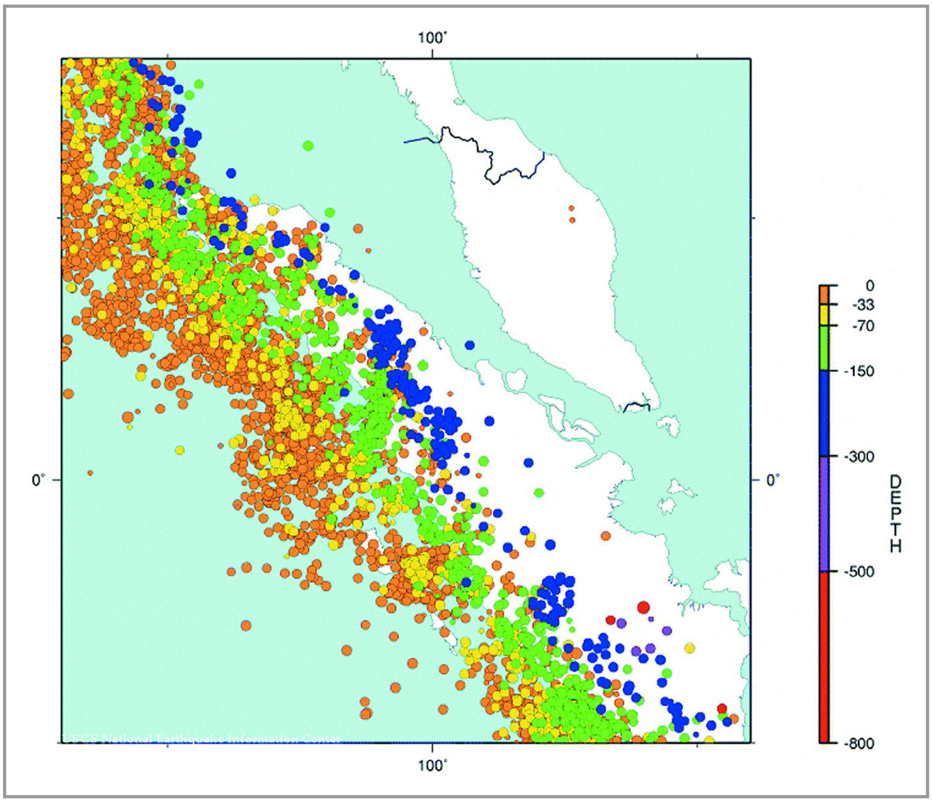

Figure 1: Earthquake Epicentres (1973 - Present) http://neic.usgs.gov/

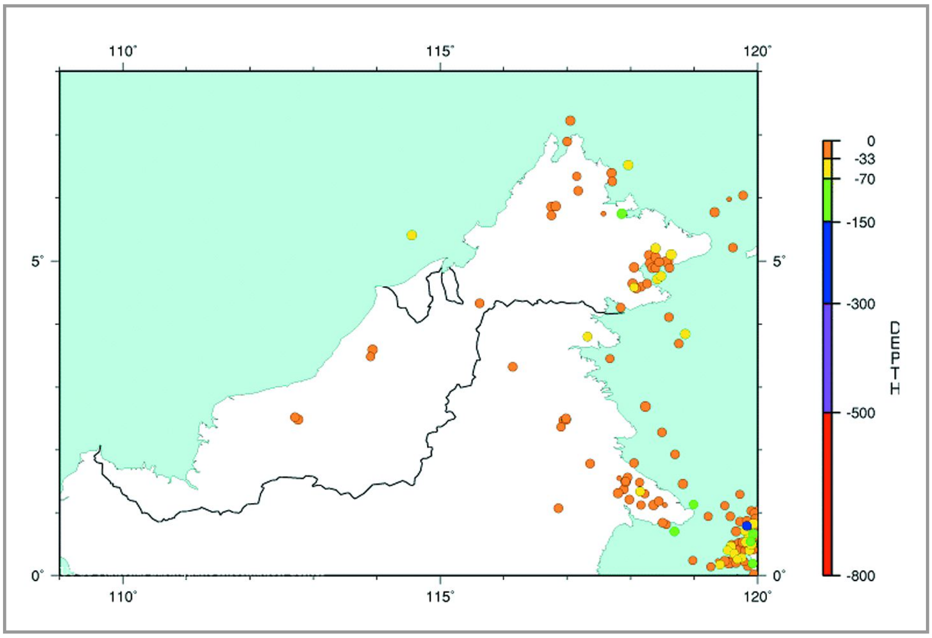

Figure 2: Earthquake Epicentres (1973 - Present) http://neic.usgs.gov/

The study implied that the local soil effect could not be neglected. Important structures to be sited on thick underlying soft soil layers that are capable of amplifying the soil response are recommended to carry out site specific hazard assessment.

3.2 Recommended long term measures

3.2.1 Develop or adopt a suitable code of practice for the construction industry

Proper guidelines and code of practice are needed for design engineers as a long term solution. These documents shall be updated and revised in every five years when new findings are evident.

Some of the considerations to be incorporated are building configuration and structural types. These are factors that need special attention especially for building designs in earthquake zone areas. Building failures in the past recorded that earthquakes around the world have shown the importance of these factors in terms of structural integrity.

The ductility design for earthquake loads is an important consideration. Normally, it is preferred to ensure that the joints of a structural frame (such as beam-column connections) be of sufficient ductility so as to allow movement under earthquake forces without joint failure. In low to moderate earthquake zones, partial ductility design may be the solution, as both safety and costs will not be compromised.

Considerations for external and internal features of buildings (such as wall claddings and services piping) that will pose as a hazard to users or the general public is to be incorporated.

3.2.2 Sensitive structures shall be checked for vulnerability when exposed to seismic ground motion

Sensitive and important structures (hospitals, fire stations, police stations, important bridges, dams, power supplies and transmission structures, telecommunication structures, etc) and other important commercial structures shall be checked for vulnerability when exposed to seismic ground motion. The Street, Drainage and Buildings Act requires buildings of over 10 years old and over five storeys in height to be periodically inspected. This inspection is proposed to be extended to include earthquake vulnerability checks.

3.2.3 Introduction of earthquake engineering education curriculum in universities and other tertiary institutions of higher learning

Earthquake engineering should be taught as an elective subject in universities in the near future. Alternatively, it can be an extension or continuation to the university's general engineering study on the dynamic analysis of rigid bodies, structural frames and foundation subsoils.

3.2.4 Sourcing of substantial rolling research fund for earthquake engineering research which also includes monitoring and risk assessment works

R&D constitutes an important part of the mitigation of an earthquake engineering programme. Possible sources of such funding include IPRA grants (via university research), CIDB research or study grants (via CREAM).

3.2.5 Continuous education for practicing engineers

Continuous education is required in the areas of earthquake engineering to develop local engineers with the knowledge to tackle potential hazards and problems arising from earthquake effects on buildings.

CONCLUSION

This position paper has outlined several recommendations to alleviate the concerns raised by the engineering profession and the general public in Malaysia, with regards to the issues related to the effects of earthquake on building structures. Useful general background information is provided in the full paper to educate and inform the public on earthquake-related matters. Priorities and actions are also highlighted in the full paper. ■

REFERENCES

[1] IEM (2007): Position paper on Issues related to Earthquake.