Rapid structural identification of existing buildings subject to earthquake ground motion: The case study of Chiang Mai and Chiang Rai

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1. INTRODUCTION

In the current research project, three work packages have been adopted. Firstly, ambient vibration measurements have been performed in a number of buildings in order to obtain the building's dynamic properties. Secondly, Finite Element Models have been created in order to check the inelastic properties of selected buildings for different earthquake hazard levels. Finally, a long-term structural health monitoring system using low-cost sensors will be adopted in order to monitor and validate the response of critical infrastructure as well as inform local staff and building occupants of earthquake impact in real-time warning.

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2. Calibrating Low Cost & Standard Accelerometers

In this study, in order to check the accuracy threshold of low cost sensors we performed a shake table test among standard sensors and low cost sensors to investigate the actual noise level of low cost sensors and to check the accuracy of both sensors based on Stationary input motion (Sine waveform input) & Non-stationary input (earthquake ground motion).

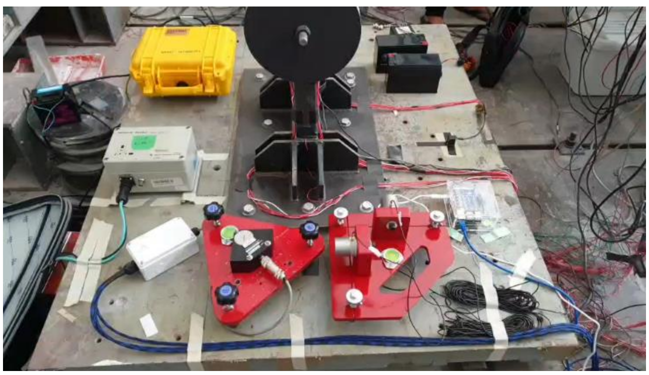


Figure 1. Set up of standard and low cost sensors for noise and stationary and non-stationary input motion.

Figure 2 show the noise level of low cost sensor is about 10-3g which might be able to detect moderate earthquake at long distance and low magnitude at close distance. The noise level of commercial sensor is about 2x10-5g could be used for Ambient Vibration measurement.

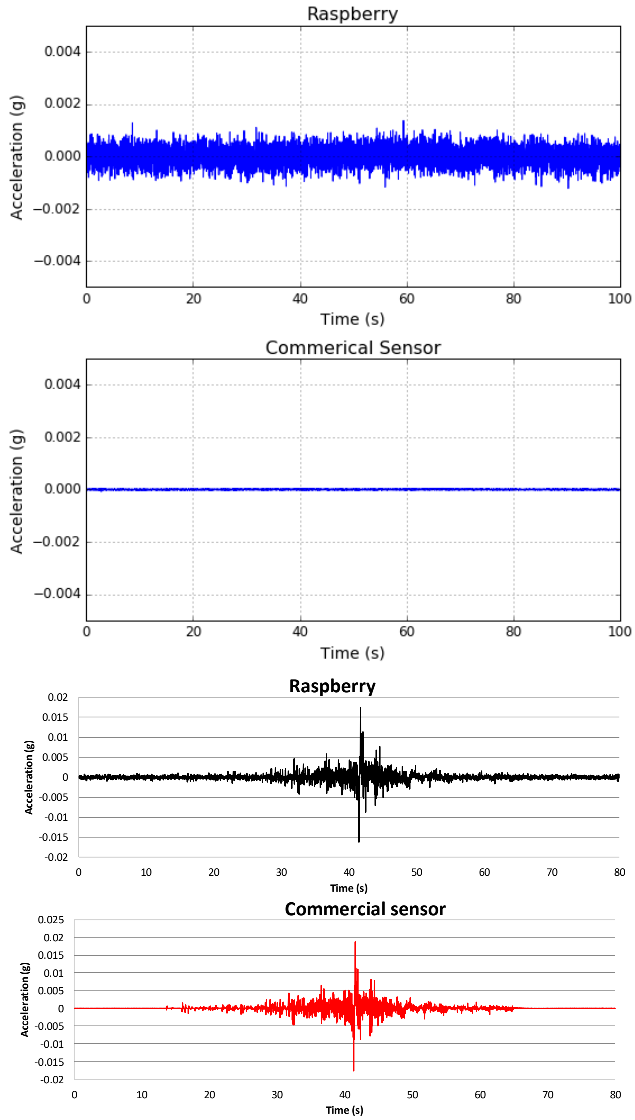
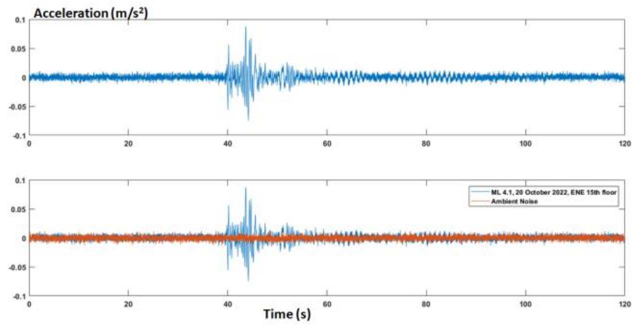


Figure 2. Comparison of noise level and ground shaking of low cost and commercial sensors.

3. Installation Tests of Low-Cost Sensors on Hospital Buildings in Chiang Mai & Chiang Rai

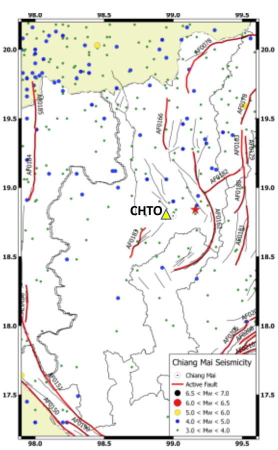
To test the performance of low-cost sensor in real critical infrastructures in order to validate real Noise level at selected infrastructures quality of signal in order to further perform structural health monitoring assessments from horizontal loads (e.g. strong wind gust, earthquake, etc.). In addition, On 20 October 2022 at 04:36:00 Thai local time, an earthquake magnitude of mb 4.2 occurred at 15 km from urban area. This earthquake was widely felt by most people in Chiang Mai. The peak acceleration observed on the 15th floor is 0.008g causing alarm for people in the hospital building. In addition, we also developed a mobile app notification system for earthquake shaking alert which can successfully send a message following mb 4.8 in Myanmar at 130 km distance from Chiang Rai Hospital.



b)

Figure 2. a) 20 October 2022 an earthquake magnitude of mb 4.2 occurred at 15 km from the hospital. b) floor acceleration located on the 15th floor due to 20 October 2022 earthquake. c) Message notification service through mobile app following mb 4.8 in Myanmar at 130 km distance from Chiang Rai Hospital

Figure 3. Location of installed low cost sensors



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4. CONCLUDING REMARKS

Developing low-cost sensors is essential for Structural Health Monitoring (SHM) of structures with a low budget for their SHM assessments. These sensors can allow engineers to leave the equipment on the structure for monitoring. To evaluate the low cost sensor performance, a set of laboratory experiments was performed. These obtained results show that low cost sensors have high noise ratio than commerical for the same number of acquired data. Furthermore, comparing the effects of low cost sensors on real building show that low cost sensor is accurate in reporting both frequency and acceleration similar to what observe n a laboratory experiment with the same time duration. A field test on real buildings in Chiang Mai and Chiang Rai have been carried out and the message notification system have been validated with a reasonable accuracy.

5. AUTHOR BIOGRAPHIES

Prof. Pennung Warnitchai has considerable experience when it comes to conducting research projects in the area of seismic hazard and risk assessment. Some of the notable research project that Prof. Warnitchai has conducted include: Seismic Hazard and Risk Assessment of Six Cities in Bangladesh; Action Plan for Earthquake Disaster Prevention and Mitigation in Bangkok, Study on Seismic Design and Retrofit of Building in Thailand. The research and consulting assignment conducted by Prof. Warnitchai covers national (Thailand) as well as regional (South East Asia, and South Asia).

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Prof. Nakhorn Poovarodom is Professor at the Department of Civil Engineering, at Thammsast University. He obtained PhD at Saitama University, 1996. He was awarded the International Activity Cooperation Award by the Japan Society of Civil Engineers (JSCE) to honour his long and continuous contribution to international activity with Japan in 2018. Prof. Nakhorn Poovarodom is an alumnus of International Graduate Program on Civil and Environmental Engineering, Saitama University (doctoral graduate of 1996).