INFLUENCE OF CONCRETE GRADE AND LEVEL OF SEISMICITY ON SEISMIC DESIGN OF REINFORCED CONCRETE SCHOOL BUILDING

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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Thesis submitted in fulfillment of the requirements
for the award of the
Bachelor Degree in Civil Engineering

Faculty of Civil Engineering and Earth Resources

UNIVERSITI MALAYSIA PAHANG

JUNE 2018

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to Allah SWT, the Most Gracious and the Most Merciful, Alhamdulillah, for the guidance and help in finishing this thesis.

I would like to express my deepest appreciation towards my supervisor, Dr. Mohd Irwan bin Adiyanto for his guidance, assistance and the valuable advices upon the completion of my Final Year Project. Thank you for giving me the chance to perform my thesis and teach me some new knowledge on earthquake.

During the research, I have learnt more about the earthquake impact on structure and also people. The after effect and consequences of earthquake is hazardous and that is why the project focus on modeling the building that can withstand the earthquake.

Apart from that, I would also want to thank my colleagues and companion, Syaqierah Tang binti Saka, Nur Jaunaa binti Sapie and Farashaheeda binti Ahmad Jani in sharing knowledge, advice and help during the completion of my thesis. In addition, my appreciation also towards Dr. Nurul Nadrah Aqilah binti Tukimat, our Faculty of Civil Engineering’s Head of Coordinator for final year project for guidance and assistance.

Last but not least, a special thanks to my beloved family for their endless support and encouragement. It gives me strength when facing the problems or hard time during the completion of the thesis.

ABSTRAK

Di Malaysia, apabila berlaku bencana alam, bangunan sekolah konkrit bertetulang (RC) akan menjadi tempat perlindungan utama masyarakat untuk kekal sehingga bencana berkurangan. Ianya adalah sangat penting untuk memastikan reka bentuk bangunan sekolah RC pada masa akan datang dapat menampung beban dari gempa bumi, yang bermaksud bahawa bangunan sekolah RC tetap berfungsi walaupun setelah berlakunya gempa bumi. Objektif kajian ini adalah untuk menentukan kesan magnitud Peak Ground Acceleration (PGA) dan kesan gred konkrit pada jumlah pengukuhan keluli. Penggunaan model untuk kajian ini adalah dua tingkat bangunan sekolah RC yang reka bentuk berdasarkan Eurocode 8. Terdapat sejumlah enam model dengan nilai berbeza PGA dan konkrit gred. Kemudian, analisis dilakukan kepada semua model dengan menggunakan Designer Struktur Tekla untuk memperoleh kedua-dua objektif tersebut. Maklumat berdasarkan jumlah keluli yang diperlukan boleh didapati dari analisis. Ia diwakili dengan menggunakan graf Spektrum Respon Reka Bentuk dan jadual-jadual yang mengandungi maklumat seperti momen lenturan. Berdasarkan analisis yang dijalankan dalam kajian ini, bangunan sekolah RC dengan PGA yang lebih tinggi memerlukan jumlah pengukuhan keluli yang lebih tinggi manakala konkrit berkadar tinggi memerlukan jumlah penguatan keluli yang lebih rendah.

ABSTRACT

In Malaysia, when there is natural disaster occur, reinforced concrete (RC) school building will be the main shelter for community to stay until the disaster dwindle. it is very important to make sure the design of RC school building in future can sustain the load from earthquake, which means it is important that RC school buildings to remain functioning even after gone through the earthquake. The objective of the study is to determine the effect of magnitude of Peak Ground Acceleration (PGA) and effect of grade of concrete on the amount of steel reinforcement. The model use for the study is two-storey RC school building which is design based on Eurocode 8. There are a total of six models with different value of PGA and grade concrete. Then, the analysis is conducted to all of the models by using Tekla Structural Designer to obtain both of the objectives. The information based on the amount of steel required is provided from the analysis. It is represented by using Design Response Spectrum graph and tabulated tables that contained information like bending moment. Based on the analysis conducted in this study, the RC school building with higher PGA required higher amount of steel reinforcement while higher grade concrete required lower amount of steel reinforcement.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

q	Behaviour Factor
q_0	Basic value of behaviour factor
k_w	Factor reflecting the prevailing failure mode
α_u	The value by which the horizontal seismic design action is multiplied, in order to form plastic hinges
α_1	The value by which the horizontal seismic design action is multiplied in order to first reach the flexural resistance
t	Thickness of slab
γ_c	Concrete density
Q_k	Live load
F_B	Base shear force
$S_d(T_1)$	Ordinate of the design spectrum at period T_1
m	Total mass of the building
λ	Correction factor
F_i	Lateral load acting on storey
z_i, z_j	Heights
m_i, m_j	Mass
α_g	Design ground acceleration
T_B	Lower limit of the period of the constant spectral acceleration branch
T_C	Upper limit of the period of the constant spectral acceleration branch
T_D	Beginning of the constant displacement response
S	Soil factor
β	Lower bound factor for horizontal design spectrum (0.2)
T	Vibration period of a linear single-degree-of-freedom system
γ_1	Importance factor
α_{gR}	Reference peak ground acceleration
η	Damping correction factor
M_{Rc}	The sum of the design values of moments of resistance of column
M_{Rb}	The sum of the design values of moments of resistance of beam
C_t	0.085 for moment resistance space steel frames, 0.075 for concrete Frames,0.05 for all other structures
H	Height of the building in

LIST OF ABBREVIATIONS

RC	Reinforced Concrete
JKR	Malaysian Public Work Department
PGA	Peak Ground Acceleration
DCM	Ductility Class Medium
DCH	Ductility Class High
DCL	Ductility Class Low
MMD	Malaysian Meteorology Department
UBC	Uniform Building Code
IMRF	Intermediate Moment Resisting Frame
USA	United States of America

CHAPTER 1

INTRODUCTION

1.1 Introduction

Earthquake is a natural phenomenon. Earthquakes are generally produces by sudden rupture of geological faults, releasing elastic strain energy stored in the surrounding crust, which then radiates from the fault rupture in the form of seismic waves (Elghazouli, 2009). Earthquake can caused a movement and ground shaking which consequently cause structural building to be unstable. Furthermore, the structural building will also experience or undergo displacement during earthquake where it can shift from its original position due to the sudden seismic force.

The seismic wave that are emits during the earthquake, shake the earth as it move through it and when the waves reach the earth's surfaces, it shake all the things on the ground which can lead to destruction. Usually, man-made structures like buildings, bridges, roads and slopes will be affected, which it can lead to injuries and fatality, loss of properties as well as the changes of landform due to ground rupture, landslides and tsunami. There are many earthquakes that occurred all over the world and it had been recorded. On 11th March 2011, an earthquake with magnitude of 8.9 occurred in Tohoku, Japan. It was the most powerful earthquake ever happened in Japan and it is one of the powerful earthquakes in the world.

Malaysia is one of the countries that are safe from earthquake as it is located at the equator of the globe which are far away from the active seismic fault zone. However, as the previous recorded earthquake that occurred in the neighbouring countries such as Thailand and Indonesia, Malaysia is occasionally subjected to tremors. Seismic design for high-rise buildings, bridges and others structure has not been practiced in Malaysia, although Malaysia experiences minor to moderate earthquakes across the country (Ramli et al., 2017). Malaysia is also a part of the complex Eurasian and Indo-Australian plate tectonics which is located on southern edge of the Eurasian Plate which is known as Sunda Plate as shown in Figure 1.1. As the earthquake happened in Southern Philippine and Sumatera, it triggered several active faults that possible for Malaysia to experienced earthquake.

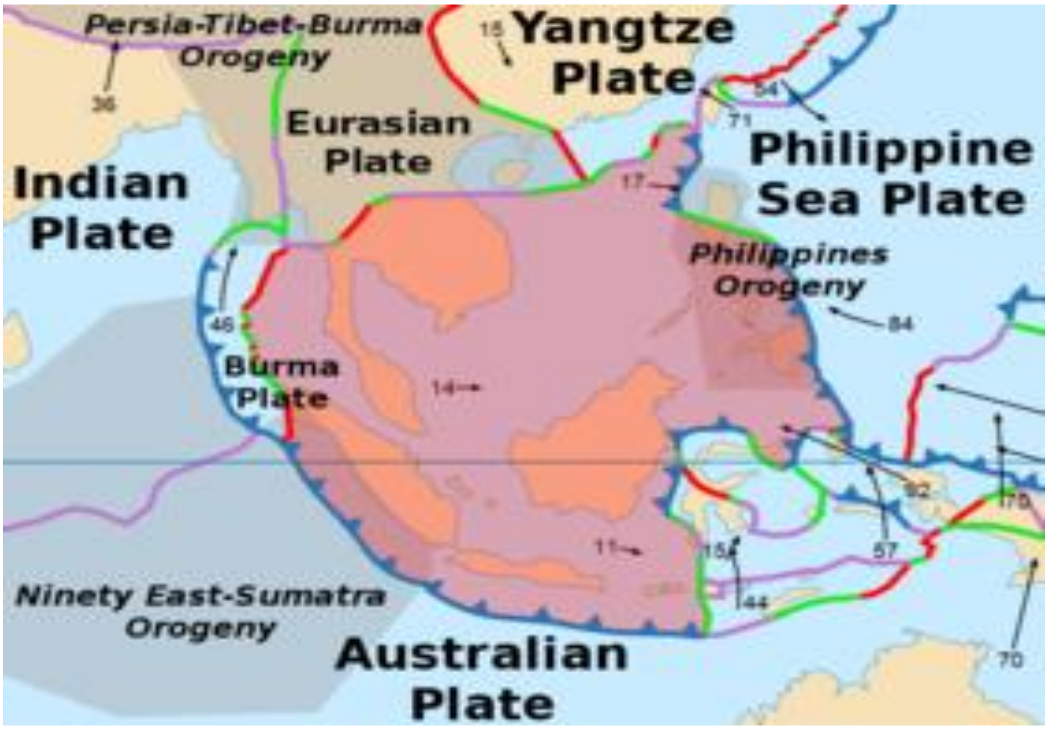

Figure 1.1 Sunda Plate Boundary

Source: (https://en.wikipedia.org/wiki/Sunda_Plate)

Recently, on 5th June 2015, an earthquake had struck Ranau, Sabah with magnitude of 6.0 which lasted for 30 seconds. It is the strongest tremors which are recorded to be affect Malaysia since 1976. Malaysian Meteorological Services Department reported that the quake struck 16km northwest of Ranau and the depth is 54km beneath the earth, occurred around 7.15 am local time. The tremors were felt in Ranau, Kundasang, Tambunan, Pedalaman, Tuaran, Kota Kinabalu, and Kota Belud (Adiyanto, 2016). Figure 1.2 represents the epicentre of the Ranau earthquake in 2015.

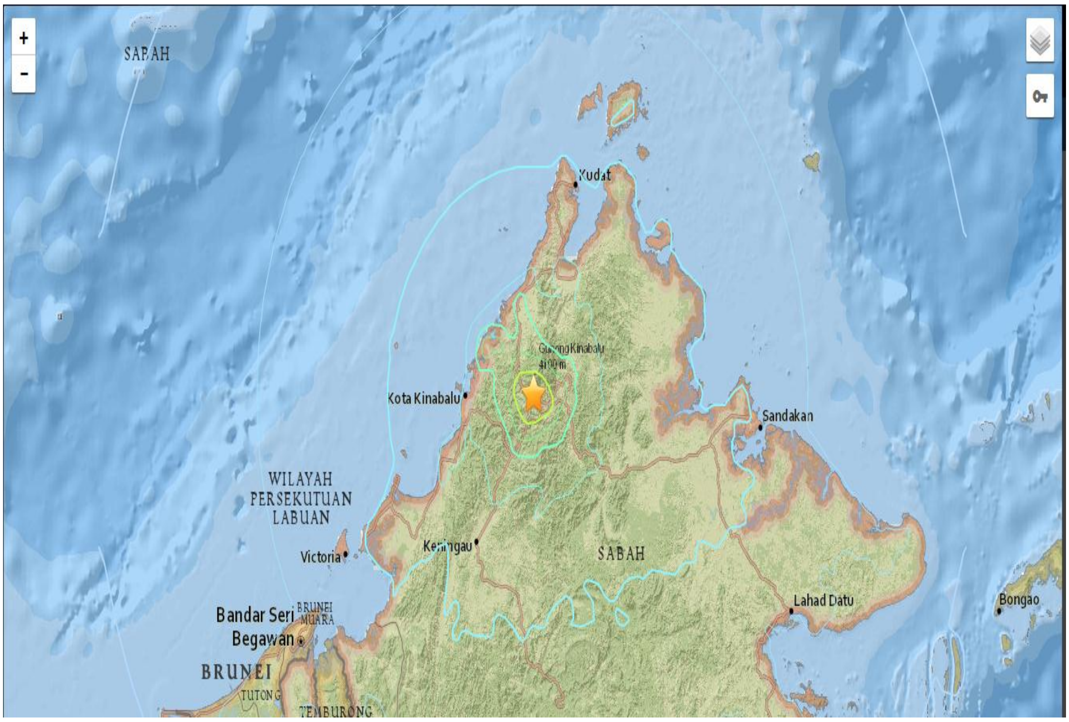

Figure 1.2 Epicentre of Ranau Earthquake

Source: (USGS, 2015)

The after effect of an earthquake could cause death which is come from collapsing buildings or facilities. Current practice in Malaysia does not consider earthquake load in building designs which lead to a more severe cause of death during disaster. As Malaysia constantly subjected to tremors, every structural engineer should take into consideration in designing man-made structures that are able to withstand seismic action.

1.2 Problem Statement

Earthquake had occurred locally and worldwide whether it is small or large magnitude. However the awareness level of Malaysian people about earthquake still very little. Malaysia had experienced several local tremors from earthquake that occurred in Sabah and Peninsular Malaysia and also far fields earthquakes from Philippine and Indonesia. During the earthquake in Ranau, Sabah on 5th June 2015, a lot of structures had damaged including one of the peaks on Mount Kinabalu known as Donkey's Ears was broken off and a total of 18 loss life. Through the events, people start to questioning the ability of structural buildings in Malaysia whether it is strong enough to withstand or resist the tremors.

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