THE EFFECT OF SOIL TYPE AND CONCRETE GRADE ON THE AMOUNT OF STEEL REINFORCEMENT USED FOR SEISMIC DESIGN OF MULTIPURPOSE HALL

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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
B. Eng (Hons.) Civil Engineering

Faculty of Civil Engineering and Earth Resources

UNIVERSITI MALAYSIA PAHANG

MAY 2019

ACKNOWLEDGEMENTS

Alhamdulillah, first of all, I want to express my deep sense of gratitude to Allah SWT for the guidance and give me strength to complete this thesis during my Final Year in Universiti Malaysia Pahang(UMP). Praise and peace be upon Prophet Muhammad S.A.W, his family and his companion.

I would like to forward my appreciation to my supervisor, Dr. Mohd Irwan Bin Adiyanto for all, whose contribution in stimulating suggestions and encouragement, helped me to coordinate my project especially in writing this report. I am highly indebted to my supervisor for his guidance and constant supervision as well as for providing necessary information regarding the project & also for his support in completing this thesis.

I would like to express my gratitude towards my parents, Azman Bin Ahmad and Khafizah Binti Jaffar and also to my colleagues, Nur Hazwani Binti Mohd Rashid, Ummu Nurulatiqah Binti Kamis, Hanis Athirah Binti Roslan, Anis Farhana Binti Mazlan and azlina Binti Nordin for their kind co-operation and encouragement which help me in completion of this project.

The success and final outcome of this project required a lot of guidance and assistance from many people and I am extremely privileged to have got this all along the completion of my project. All that I have done is only due to such supervision and assistance and I would not forget to thank them.

ABSTRAK

Dewan Serbaguna merupakan tempat awam di mana orang ramai menggunakan tempat tersebut untuk pelbagai tujuan. Ia juga bole bertindak sebagai tempat sementara untuk berlindung sekiranya terjadi sebarang bencama terutama dalam kes ini adalah bencana gempa bumi. Walaupun Malaysia tidak terletak di lingkaran gunung berapi, tetapi itu tidak membawa maksud bahawa Malaysia akan selmat daripada bencana terseebut buat selamanya. Oleh itu tempat berlindung amat penting untuk dibina dan direka bentukk berseesuaian dengan ciri-ciri yang kukuh dan kuat untuk menahan daya kuasa daripada bencana gempa bumi. Kebanyakan bangunan di Malaysia tidak mengamalkan reka bentuk seismik pada bangunan. Hal ini sangat membimbangkan pihak berkuasa tempatan seperti Jabatan Kerja Raya Malaysia (JKR). Bangunan awam seperti dewan serbaguna adalah amat penting untuk memastikan keselematan bangunan tersebut untuk kegunaan orang awam sekerinya bencana gempa bumi terjadi di Malaysia. Objektif kajian ini melibatkan dua tujuan iaitu mengenal pasti kesan jenis tanah dan konkrit gred terhadap jumlah pengukuhan keluli. Selain itu, kajian projek ini berteraskan kayu ukur yang melibatkan pengaruh jenis tanah dan juga kesan gred konkrit terhadap jumlah keseluruhan pengukuhan keluli. Penggunaan 12 model bangunan dengan menggunakan dua parameter yang berbeza telah digunakan untuk penganalisaan. Kedua-dua parameter yang digunakan adalah Jenis Tanah A, B, C, D dan E dan juga Konkrit Gred 25 dan juga Konkrit Gred 35. Kesemua 12 model direka berdasarkan Eurocode 8 dan dianalisa menggunakan Perisian Struktur Tekla. 12 model bangunan yang digunakan adalah Dewan Serbaguna 3-tingkat dengan ketinggian 4.0m begi setiap ketinggian tingkat dan panjang bangunan sebanyak 40.0m dengan lebar 24.0m. Model bangunan direka dengan menggunakan perisian struktur Tekla. Luas kawasan bagisetiap tingkat adalah 960 meter persegi. Dua dimensi rasuk konkrit digunakan berukuran 300mm x 500mm dan 300mm x 600mm manakala, dimensi tiang adalah 500mm x 500mm untuk semua dimensi tiang. Di samping itu, ketebalan papak yang digunakan untuk semua tingkat adalah 250mm. Ketinggian bangunan serbaguna yang digunakan diklasifikasi dalam bangunan rendah berdasarkan Biro Perancangan dan Kemapan, 2013. Bangunan Serbaguna dengan Ketinggian 3 tingkat sesuai dijadikan sebagai tempat perlindungan bencana sementara. Dewan Serbaguna tersebut dijangka akan terletak di Tambunan, Sabah. Segala analisa kebanyakannya diterjemahkan dalam bentuk graf dan analisa pada Graf Spektrum Respon Reka bentuk turut dianalisa dalam kajian ini. Berdasarkan analisis yang diperolehi, boleh disimpulkan bahawa tanah yang bersifat lembut dan konkrit gred yang lebih rendah memerlukan jumlah pengukuhan keluli yang lebih tinggi. Untuk Dewan serbaguna pada Jenis Tanah D mempunyai peningkatan peratusan besi yang paling tinggi sebanyak 59% daripada model bangunan yang tidak mempunyai reka bentuk seismik. Manakala, Konkri Gred 25 memerlukan peratusan besi yang tinggi berbanding Konkrit Gred 35 sebanyak 18%. Kesimpulanya, kedua-dua parameter tersebut memainkan peranan yang amat penting dalam peratusan keseluruhan besi bagi mereka bentuk bangunan seismic di Malaysia.

ABSTRACT

Multipurpose Hall is a public place where people use the space for various purposes. It also can be use as temporary place for shelter if any disaster happens, especially in case of earthquake disaster. Although, Malaysia is not located in the specific ring of fire, but that does not mean Malaysia is totally safe from earthquake disaster. Hence, temporary shelter is very important to be built and designed with strong and fit structure component to withstand the force from the ground shaking. Most buildings in Malaysia do not practice seismic design on buildings. This is a very alarming cases for local authorities like Public Works Department (JKR). Public buildings like Multipurpose Halls is very important to ensure the safety of the structure building in order for it to act as a temporary shelter for the use of civilians when earthquake occurs in Malaysia. The objective of this research is to determine the effect of soil type and concrete grade on the amount of steel reinforcement required. In addition, this project research is based on parameter of type of soil and concrete grade involving 12 building models. The 12 building models using two different parameters is used for analysis. The two parameters are Soil Type A, B, C, D, and E and Concrete Grade 25 and Concrete Grade 35. All 12 building models are based on Eurocode 8 and analyzed using Tekla Structural Software. Model of building used is 3-storey of Multipurpose Hall with height of 4.0m for each floor and 40.0m length with width of 24.0m for 12 buildings model respectively. The building models is designed by using Tekla Structural Software. The area for each floor of the Multipurpose Hall is 960 square meter. Two dimension of beam is used in the design which are 300mm x 500mm and 300mm x 600mm by using concrete beam while dimension of column is 500mm x 500mm for all column size. The material of column used is also concrete. In addition, the thickness of slab used for all floor is 250mm. The building model is considered as low rise since it is less than 6 stories according to Bureau of Planning and Sustainability, 2013. The level of 3-storey is suitable for multipurpose hall building function as hall itself and also as immediate disaster relief shelter. This Multipurpose Hall is assumed to be located in Kundasang, Sabah. All the analysis result is mostly interpreting in term of graph and Design Response Spectrum also has been discussed in the thesis. Based on the result, it can be concluded that soft soil and low concrete grade required higher amount of steel reinforcement. Multipurpose Hall designed on Soil Type D has the highest total amount of steel with the percentage of 59% compared to multipurpose hall designed based on non-seismic design. In the other hand, Concrete Grade 25 has higher total amount of steel compared to concrete grade 35 with the difference of 18%. Conclusion that can be made is both parameter play a crucial role in designing seismic building in Malaysia.

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LIST OF SYMBOLS

α_{gR}	Peak Ground Acceleration
α_g	Design ground acceleration
q	Behavior factor
F_b	Base shear force
$S_d(T)$	Design response spectrum
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 range of spectrum
T_1	Fundamental period
S	Soil factor
γ_1	Importance factor
M_{Ed}	Bending moment
V	Shear force

LIST OF ABBREVIATIONS

BS	British Standard
DCL	Ductility Class Low
DCH	Ductility Class High
DCM	Ductility Class Medium
GL	Gravity Load
JKR	Malaysian Public Work Department
PGA	Peak Ground Acceleration
RC	Reinforced Concrete
SDOF	Single Degree of Freedom

CHAPTER 1

INTRODUCTION

1.1 Background

When earthquake happens, disaster relief shelter is important to provide immediate and short term shelter for the victims of the disaster. It is used to provide private and secure places for people who survived. Therefore, it is very important to provide buildings that consider the design of earthquake provision where it is a rare practice in building design in Malaysia. According to STAR newspaper published by Yuen Meikeng (2017), Malaysians are not immune to earthquakes and the incident on June 8, 2015 where 5.6 magnitude earthquakes struck Medan, Indonesia and the wave's ripples reached Peninsular Malaysia and affected Kampung Kuala Muda. In addition, according to the same source which reported a year after the incident, a 6.0 magnitude struck Ranau which lasted for 30 seconds and resulted to 18 deaths of people and it is the strongest earthquake struck Malaysia since 1976. Malay mail website reported that the natural disaster of earthquake has damaged the iconic peak of Mount Kinabalu which is the "Donkey Ears" and also destroyed property in Ranau.

Figure 1.1 Sabah Earthquake

Even though, there is no massive earthquake has affected Peninsular of Malaysia but this doesn't mean it is spared from the natural disaster. To be clear, geography of Malaysia doesn't have any guarantee that state Malaysian region will not have natural disaster.

Earthquake is originally happened when there is sudden force on underground rock that breaks along a fault. The sudden release of energy produced wave that result in seismic waves and create a ground shake. Earthquake normally occurs along the edge of continental plates. The outer layer of earth's crust is made up of several pieces called as plates. Oceanic plates are for plates under the oceans. These plates are usually meet against each other or pass each other and when the plates are running into each other, earthquakes occurred. When two rocks of plates are rubbing against each other and not moving then, the stress keep on acting between the two rocks, after a while it will overcomes the friction and create earthquake. This sudden slip on a fault is the core of earthquake and the energy in term of waves is the shaking that we feel.

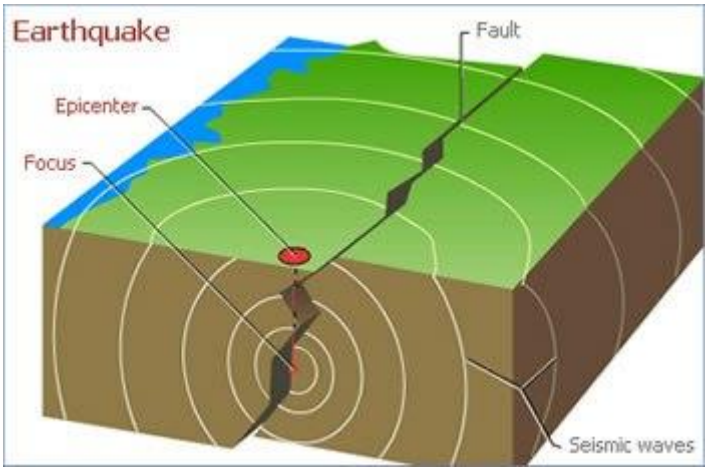

Figure 1.2 The elements involved in earthquake

Earthquake also occurred due to the cracks of fault where it may occur far from the edges of plates. Fault is cracks under the ground where a plate or two plates are moving against each other in different directions. It happened from all the bumping and sliding thee plates do. There are two types of faults which dip slip faults and strike-slip faults. Dip slips fault consist of two types which are normal and reverse faults. Where the normal fault caused the footwall moves away from hanging wall due to tension and reverse fault is toward the hanging wall due to compression. While strike slips are cracks between two plates sliding

past each other. It also consists of two types, right and left lateral slips. There is no exact prediction on the time of when earthquake will occur. It is always sudden and highly unpredictable.

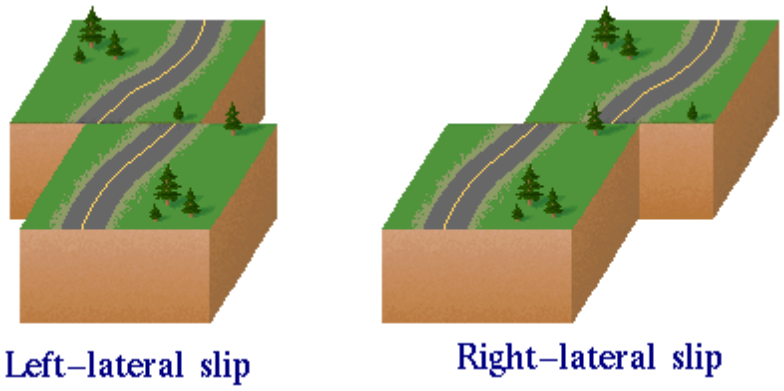

Figure 1.3 Types of strike slip of earthquake

Waves that created from earthquake are like an object dropped on a still water and send out the waves which in earthquake term is called seismic waves. Seismic waves can be categorized in two types, which is body waves and surface waves that travel along earth's surface which produced the greatest vibration and the most destructive one. Body waves consist of two types which is primary (P) waves and secondary (S) waves as shown in Figure 2.4 below. They are able to travel from the focus of an earthquake through the interior of earth's inner layer on the earth's surface. P-waves travel faster than S-waves at the speed between 4km to 8km per second and S-waves travel at slow speed between 2.5km to 4km per second. P-waves are normally can be head and often be felt except in situation where big impact earthquake that can cause damage. The direction of P-waves is propagating to the ground compared to S-waves where it ripples perpendicular to the direction of propagation (Kurisaki et al., 2018).

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