BUILDING PERFORMANCE WITH DIFFERENT BEDROCK RESPONSE SPECTRUM

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ABSTRACT

Response spectrum is a very useful tool in earthquake engineering for estimating the performance of structures. In this research, attenuation equation will be used to find the spectral acceleration of bedrock to predict reliable and more accurate ground motions as far 600 km from potential earthquake sources. According to historical records, the earthquakes that influenced Peninsular Malaysia are originated from two earthquake faults: the Sumatra subduction zone and Sumatra great fault zone. The worst earthquake ever occurred in Sumatra subduction zone is identified as $M_w = 9.11$ and $M_w = 7.81$ for Sumatra fault zone. These data were then used to predict the spectral acceleration of bedrock in Malaysia using Probabilistic Seismic Hazard Analysis (PSHA). The maximum response spectrum of bedrock from Sumatra subduction zone for megathrust is 67 gals, benioff is 60 gals and fault zone is 90 gals for site location in Kuala Lumpur while for Pulau Pinang the values of response spectrum from Sumatra subduction zone for megathrust is 57.5 gals, benioff is 47.78 gals and fault zone is 58.33 gals. Performance of building shows that the values of moment for combination load 2 increases about 15.07 percents for column 1 and approximately 4.70 percents for beam 2. Based on the results the performances of building during earthquake loadings are larger than without earthquake loading.

ABSTRAK

Reaksi spektrum merupakan alat yang sangat berguna dalam kejuruteraan gempa untuk menganggarkan prestasi struktur. Dalam kajian ini, persamaan pengecilan akan digunakan untuk mencari percepatan spektral di batuan dasar untuk meramalkan gerakan tanah yang lebih tepat sejauh 600 km dari sumber gempa yang berpotensi. Menurut catatan sejarah, gempa bumi yang mempengaruhi Semenanjung Malaysia ini berasal dari dua sesar gempa iaitu di zon subduksi dan zon sesar Sumatera Sumatera. Gempa bumi terburuk yang pernah terjadi di zon subduksi Sumatera dikenalpasti sebagai Mw= 9,11 dan Mw = 7.81 untuk zon sesar Sumatera. Data-data ini kemudian digunakan untuk meramalkan percepatan spektrum di batuan dasar di Malaysia menggunakan analisis dengan kaedah kebarangkalian (PSHA). Reaksi spektrum maksimum di batuan dasar dari zon subduksi Sumatera megathrust adalah 67 Gals, Benioff / intraslab adalah 60 Gals dan zon sesar adalah 90 Gals untuk lokasi di Kuala Lumpur sedangkan untuk Pulau Pinang nilai reaksi spektrum dari zon subduksi Sumatera megathrust adalah 57.5 Gals , Benioff / intraslab adalah 47,78 Gals dan zon sesar adalah 58,33 Gals. Prestasi bangunan menunjukkan bahawa nilai momen untuk beban gabungan 2 meningkat sekitar 15.07 peratus untuk tiang 1 dan anggaran 4.70 persen untuk rasuk 2. Berdasarkan keputusan prestasi bangunan apabila beban gempa yang lebih besar daripada tanpa gempa.

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LIST OF SYMBOLS

C	-	Coefficient
H	-	Depth
k	-	Stiffness
m	-	Mass
M	-	Earthquake magnitude
M_b	-	Body wave magnitude
M_s	-	Surface wave magnitude
M_w	-	Moment magnitude
N	-	North
PGA	-	Peak Ground Acceleration
r_{rup}	-	Closest distance to the zone of rupture
R	-	Source to site diatance
S	-	South
T_R	-	Return Period
λ_m	-	Mean annual exccedance

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CHAPTER 1

INTRODUCTION

1.1 Background

An earthquake is the result of a sudden release of energy in the Earth's crust that creates seismic waves. Earthquakes are recorded with a seismometer, also known as a seismograph. The moment magnitude of an earthquake is conventionally reported, or the related and mostly obsolete Richter magnitude, with magnitude 3 or lower earthquake being mostly imperceptible and magnitude 7 causing serious damage over large areas.

At the earth's surface, earthquake manifests themselves by shaking and sometimes displacing the ground. When a large earthquake epicenter is located offshore, the seabed sometimes suffers sufficient displacement to cause a tsunami. The shaking in earthquakes can also trigger landslides and occasionally volcanic activity.

The major tectonic activity occurring in Malaysia surrounding Indonesia is due to the convergence of three major plates. The Eurasian, Pasific and Australian-Indian plates, along with some minor plates, are all actively moving towards each other in the Southeast Asia region (Figure 1.1). The Indian Ocean floor is sliding to the north under the islands of Java and Sumatra, resulting in a large subduction zone. Most earthquake events within Indonesia occur in the Sunda subduction system. Seismic events of the Sunda system are concentrated at shallow depths mostly above 30km.

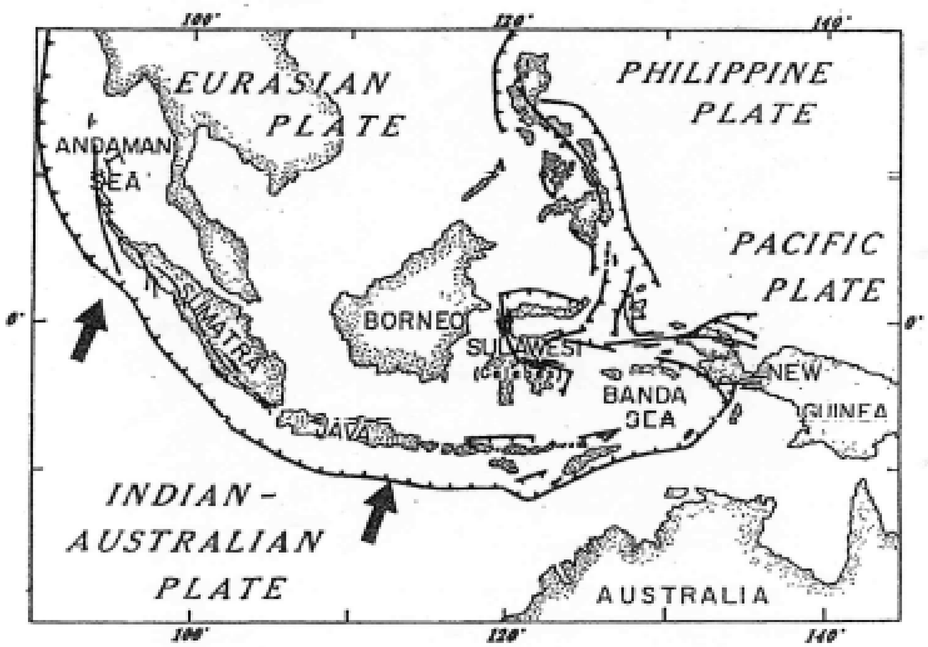

Figure 1.1 Schematic of plate tectonic

Peninsular Malaysia is located on a stable part of the Eurasian Plate, buildings on soft soil are occasionally subjected to tremors due to far-field effects of earthquake in Sumatra (Balendra et al. 1990). In the last few years, tremors were felt several times in tall buildings in Kuala Lumpur due to large earthquake in Sumatra. The mechanism for such tremors is illustrated in Figure 1.2.

The seismic waves, generated from an earthquake in Sumatra, travel long distance before they reach Malaysia bedrock. The high frequency earthquake waves damped out rapidly in the propagation while the low frequency or long period waves are more robust to energy dissipation and as a result they travel long distances.

Thus the seismic waves reaching the bedrock of Malaysia Peninsula is rich in long period waves, and significantly amplified due to resonance when they propagate upward through the soft soil sites with a period close to the predominant period of the seismic waves. The amplified waves cause resonance in buildings with a natural period close to the period of the site, and the resulting motions of buildings are large enough to be felt by the residence.

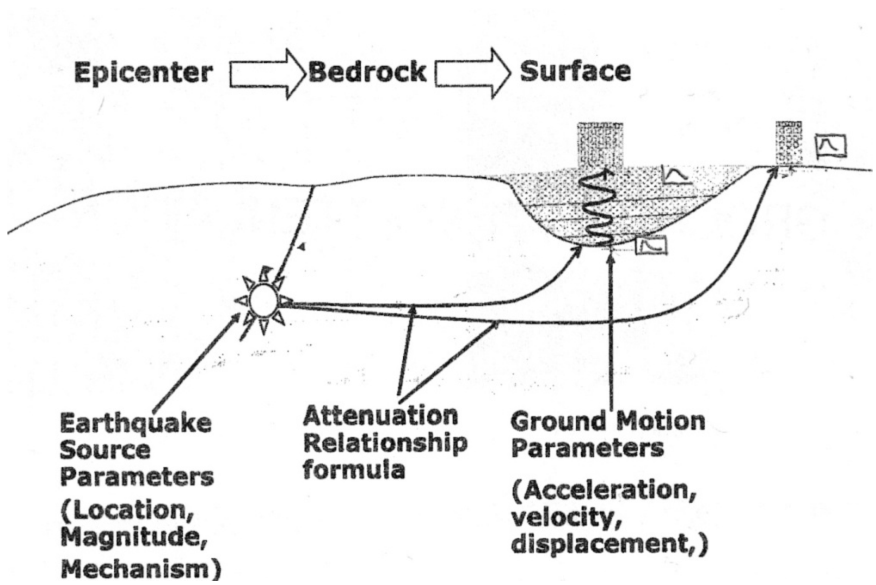

Figure 1.2 Schematic illustration of wave propagation through engineering bedrock and soil surface

1.2 Problem Statement

The magnitude of ground motion at varying distance from the Sumatra earthquake sources is determined from attenuation models. Statistical regression analysis could be used to develop such attenuation models (Youngs 1997, Sadigh 1997; Petersen et al. 2004; Azlan et al. 2005; Campbell 2004). However, as there were not enough strong motion data in this region relating the ground acceleration with magnitude and distance, this conventional empirical modeling approach was not feasible.

The bedrock motions can be significantly amplified when the natural period of the soft soil is close to the predominant natural period of the bedrock motions, and can be further enlarged if the building possesses a natural period which is close to the natural period of the site. For this research to find out natural period and performance of the building with different mechanism and fault distances.

1.3 Objective of the Study

The objectives of the research are:

- To identify suitable attenuation equation.
- To find response spectrum of bedrock.
- To find performance of building with different response spectrum.

1.4 Scope of the Study

The scope of research would cover as mention below:

- Performance of attenuation equation with different mechanisms and fault distance
- Performance of PGA and response spectrum of bedrock.
- Performance of building with different response spectrum

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