

PAPER ID 19

Local site effect evaluation through Horizontal-to-Vertical Spectral Ratio (HVSr) in Johor Bahru

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Abstract: Earthquake is one of the common natural disaster that occurs worldwide which causes catastrophic damage towards the affected area either by the earthquake event itself or earthquake-induced natural disaster such as tsunami and landslides. Malaysia is known to have little to no seismic activities but an incident in Ranau, Sabah in 2015 had taken the whole nation by surprise with magnitude 6 and caused 18 casualties. This event had shown that Malaysia have yet to be prepared for such occurrence again. The possibility of experiencing tremors due to far-field earthquake also should not be disregarded as Malaysia is located in between high seismicity events which are the Philippines Plate in the east and the Indo-Australian Plate in the west. It is known that seismic waves will be attenuated into harmless waves after propagating for quite a distance from the source. Thus, theoretically said that the site that is closest to the earthquake sources will experience much worst hazard compared to a far distance site due to the wave attenuation. An earthquake with short-period ground motion will attenuated relatively quick and the vibrations will only affect a mid-rise building or a single-story structure. A long-period earthquake ground motions will travel for a longer distance without being attenuated and a tall structure will experience far greater shaking as the structure resonates. It was reported that cracks were visible on one of the building in Gelang Patah, Johor Bahru due to the far-field earthquake originated from Sumatra earthquakes on 25 July 2004 with magnitude of Mw 7.3. Hence, a far-field earthquake cannot be taken lightly and should be addressed properly by conducting suitable method to reduce aftermaths of earthquake occurrences. This study aims to evaluate the local site effect in Johor Bahru by generating seismic microzonation maps from the measurements of natural frequency and amplification factor through the application passive seismic survey known as Horizontal-to-Vertical Spectral Ratio (HVSr). A gridded acquisition survey design of 50 points with 1 km x 1 km interval had been plotted around Johor Bahru prior to data collection. The time recording for microtremor data at each point is set approximately for 60 minutes. The analysis of microtremor data collected in Johor Bahru shows that the area is dominated by loose alluvium deposits and stiff soil, with the average natural frequency ranging from 1 to 3 Hz. While the extracted amplification factor from HVSr curves depicts the lowest value of 1.61 and the maximum value is 8.65 which is significantly high. The integration of both parameters shows that the site having lower natural frequency reading and high application factor requires more attention and mitigation plan compared to other region as it is more vulnerable towards any impact of earthquakes.

Keywords: HVSr, microtremor, earthquakes, local site effect