Peak Ground Acceleration for Kulon Progo Regency
Based on Microtremor Measurements

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Abstract—Peak ground acceleration for Kulon Progo Regency had been determined using microtremor data taken from 38 sampling locations. Data analysis was done using Horizontal to Vertical Spectrum Ratio (HVSR) method to get pre-dominant period and Kanai method to get the peak ground acceleration value based on the pre-dominant period data. The results show that the peak ground acceleration value for Kulon Progo Regency is between 16 cm/s² and 61 cm/s². The highest value is found at Kokap and the lowest value is found at Wates.

Keywords: Peak Ground Acceleration, Microtremor, Kulon Progo

I. INTRODUCTION

Indonesia is located at the joint of three major active tectonic plates, they are Indo-Australia plate in the South moving northward with velocity of 7 cm per year, Eurasia plate in the North moving southward with velocity of 13 cm per year, and Pacific plate in the East moving westward with velocity of 10 cm per year. Yogyakarta is one of several cities located in the Southern part of Java island which have direct boundary to Indian Ocean and complex geologic structure. On January 25th, 2014, a major earthquake centered at 8.48 S 109.17 E (104 km northwest of Kebumen Central Java, depth of 48 km) with magnitude of 6.5 Richter Scale shook and brought infrastructure devastation such as road, electricity line and water supply. Based on the location and depth, it was caused by tectonic activity at the plate boundary between Eurasia plate and Indo-Australia plate. It was measured at intensity of III MMI in Yogyakarta [1]. Regional Disaster Management Authority (BPBD) of Kulonprogo Regency Yogyakarta noted several building had minor destruction in Galur, Kalibawang dan Lendah district after the Kebumen earthquake [2].

Kulon Progo Regency is one of many area which are prone to earthquake. However, there is no research yet about the peak ground acceleration for the area. Peak ground acceleration is the maximum ground acceleration in a location when an earthquake is taken place. This physical quantity is important because it can be used to predict the intensity of an earthquake and to determine which one of the specific area in Kulon Progo prone to the disaster. One of several method to determine the peak ground acceleration value is using the microtremor data. Microtremor is natural vibrations produced by human activities and environment. To get the peak ground acceleration from microtremor data, we can use Kanai method which consider the site’s surface soil characters and earthquake parameters. The value of peak ground acceleration can be used to map the earthquake risk around Kulon Progo Regency.

II. METHOD

This research was conducted by measuring microtremor signal on 38 measurement points around Kulon Progo Regency. Measurement points was set as a grid system where each point was separated as far as 4 km. The grid occupied an area confined between 7.654 S – 7.984 S and 110.069 E – 110.274 E and representing the whole regency. The signal was measured for 30 minutes following the SESAME European Research Project guideline [3].
Equipment used in this research were TDV-23S three component seismometer, TDL-303S digital portable seismograph, Garmin Global Positioning System (GPS), compass, geology map of Kulon Progo Regency and microtremor measurement sheet from SESAME. Data analyzing was done using Mapinfo, Datapro, Sasarray-Geopsy and Surfer 11.

Microtremor signals were analyzed using Horizontal to Vertical Spectrum Ratio (HVSR) to give predominant frequency ($f_0$) and amplification factor ($A$). Peak ground acceleration then can be calculated from predominant frequency and Kebumen January, 25$^{th}$ 2014 earthquake data using Kanai method.

III. RESULTS AND DISCUSSION

Based on data analysis, we get map of predominant frequency (Figure 1) and peak ground acceleration (Figure 2).

As can be seen from Figure 1, the predominant frequency are higher in some measurement points and lower in other points. The highest value obtained is 14.08 Hz at measurement point 27 (Pengasih district) and the lowest value is 0.96 Hz at measurement point 32 (Wates district). High frequency means the area can produce more vibration within a period of time thus the displacement is small to produce such frequency, whereas lower frequency means the area can produce less vibration within a period of time thus the displacement is big and prone to infrastructure destruction. High frequency value usually is found in hard soil and thin sediment area, while low frequency value usually found in soft soil and thick sediment area. This explanation match quite well with the soil characters in the measurement points.
From predominant frequency and earthquake parameter from Kebumen earthquake, we can get the peak ground acceleration for the measurement points. The peak ground value range is between 16 cm/s² and 61 cm/s². The highest value is found at measurement point 19 (Kokap subdistrict) and the lowest value is found at measurement point 32 (Wates subdistrict). Figure 2 shows that Samigaluh, Kokap, Nanggulan and Sentolo district have higher value of PGA, while Kalibawang, Pengasih, Wates, Panjatan, Galur and Lendah have lower value of PGA.

IV. CONCLUSION

Based on the data and discussion, we can conclude that:

1. The value of predominant frequency found in the microtremor measurement is distributed between 0.96 Hz – 14.08 Hz. The highest value is found at Pengasih and the lowest value is found at Wates.
2. The value of Peak Ground Acceleration (PGA) for Kulon Progo Regency is distributed between 16 cm/s² and 61 cm/s². The highest value is found at Kokap and the lowest value is found at Wates.

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REFERENCES


