Fundamental Frequency Anomaly Around Cimeta River, Padalarang, West Java

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Abstract. Lembang Fault segment Cimeta and Cimandiri Fault segment Padalarang assumed to coincide at Padalarang, which lies at Ngamparah and Bojongkoneng district, Bandung, West Java. Padalarang is an area with high traffic and infrastructure conditions, such as freeway overpass named Cimeta bridge, rail bridge and soon-to-be tunnel of fast train Jakarta – Bandung. The presence of these faults becomes a threat to both residents and the infrastructures. We performed an investigation of seismic microzonation using a Horizontal Vertical Spectral Ratio in the area. Microtremor measurement has been done in 37 points widespread from the Cimandiri Fault segment Padalarang to Lembang Fault segment Cimeta. The method could provide information about the fundamental frequency and amplification factor of earthquake propagation to the site from the analysis of spectral ratio microtremor data. Fundamental frequency associated with the thickness of sedimentation meanwhile amplification factor indicates the impedance contrast at the site. The result shows that the fundamental frequency of Ngamprah and Bojongkoneng area around 1-6 Hz indicated deep sedimentation. However, we found an anomaly of the high fundamental frequency of 9 Hz at the Cimeta river. Therefore, we attempted to conduct another measurement around the area at different times and conditions. Three measurements of microtremor around the Cimeta river have shown that the area has high fundamental frequencies around 9-11 Hz. These results may indicate the presence of both bedrock and geological structure of Lembang Fault at the Cimeta river.

1. Introduction
According to the digital elevation model, both Lembang and Cimandiri Faults are assumed to have coincided in Ngamprah and Bojongkoneng Districts areas. Characteristics of Lembang Fault is strike-slip with a sinistral movement with a slip rate of around 3-5.5 mm/yr and has the potential to generate an earthquake with a magnitude of around 6.5 to 7 Mw if all of Lembang fault segment activate [1]. Meanwhile, Cimandiri fault is a strike-slip fault with the sinistral movement. Supendi et. al. (2018) [2] presented that the Cimandiri fault segment Padalarang has low seismicity than segment Loji and Cidadap. However, the existence of these faults becomes big threats for the surrounding area affected by the earthquake especially for the residents and infrastructure around the area such as railway bridge, freeway overpass and construction of fast train tunnel. To understand the potential hazard of the...
earthquake in this area, we applied the Horizontal Vertical Spectral Ratio method to analyze microtremor data.

Measurement of microtremor signal has been done in 37 points widespread from the Cimandiri Fault segment Padalarang to Lembang Fault segment Cimeta. Analysis spectral of microtremor data could provide information about the fundamental frequency and amplification factor. Fundamental frequency associated with the thickness of sedimentation meanwhile amplification factor indicates as impedance contrast at the site where a large peak of spectrum curve associate with velocity contrast [8]. From the result of 37 points of microtremor signal, we found anomaly of high frequencies located around the Cimeta river which correlates with the Lembang Fault segment Cimeta. Therefore, we conducted another two measurements around the area to have a better understanding of the factors of high frequency fundamental.

2. Horizontal to Vertical Spectral Ratio (HVSR)

Horizontal to vertical spectral ratio is a method to analyze the spectrum of microtremor signal which consisted of Rayleigh wave and body waves which was introduced by Nakamura (1989)

Microtremor signal contains information to identify the mechanical properties of the Earth's subsurface such as seismic velocity [4]. Despite that, the analysis of the microtremor signal could estimate the site's fundamental frequency and amplification factor [3,4,5]. These methods calculate the ratio of Fourier spectra of microtremor signal component horizontal to vertical and the maximum ratio is indicated as strong impedance contrast at depth [6,4]. Marjiyono (2010) [7] said the amplification factor equivalent to a maximum of ratio spectra Horizontal to vertical. To accurately analyze the fundamental frequency and amplification factor, we used a standard of reliability and clarity peak from SESAME [8].

3. Data Acquisition and processing

The acquisition of microtremor data located around the Ngamprah and Bojongkoneng area, Bandung, West Java with a total of 37 microtremor recorder data (Figure 1). The recording duration of the microtremor signal around 25-30 minutes and interval 250-300 m. The instrument used in the acquisition of microtremor signal was 3 – channels McSEIS – MT NEO from LIPI. Geologically, a measurement performed on top of the tuff or sedimentation of volcanic deposits from Mt. Tangkubanparahu. Suspected has deep sedimentation and has a low frequency fundamental. Besides, the morphology of
microtremor signal recording is hills and valley, located in around residents and performed in an area with high activities such as transportation and construction sites of infrastructure.

To obtain frequencies fundamental and amplification factors, we used GEOPSY software to processed microtremor signal. Microtremor signal contains not only Rayleigh and body waves but also background noise from the local site. Therefore, to process only the Rayleigh wave, we used to filter signal Butterworth with range 1-7 Hz. Also, we used the STA/LTA of 0.5 s to 30 s. Interpretation of the H/V curve can be done if filling the standard of reliability and clarity peak of the H/V curve [8].

The result of the H/V curve showed that Ngamprah and Bojongkoneng have fundamental frequencies around 1.4-5.2 Hz. However, we found a high anomaly of frequency fundamental at Ngamprah, around the Cimeta river. The fundamental frequency at these areas is larger than that of the surrounding area with value 10 Hz. SESAME [8] said if fundamental frequency that obtains in the site differently than the surrounding area, the frequency can be invalid caused local site has a homogeneous characteristic. Therefore, we performed another microtremor signal recording with interval 60 to 120 m from the initial location to have a better understanding of the caused of high frequency fundamental.

4. Result and Discussion
The result of microtremor signal processing shown that frequency fundamental at Ngamprah 1.4-4 Hz and Bojongkoneng around 4-6 Hz. H/V curve obtained from 37 microtremor signal recording indicate 3 type which is an unclear sharp peak, clear peak and unclear broad peak [8]. The unclear sharp peak of the H/V curve is frequently found in an urban setting or residential areas with characteristics two sharp peaks shown in H/V curves meanwhile unclear broad peak indicates with multiple peaks at the adjacent frequency in H/V curve. Despite that, we also found high-frequency clear peak around 9-10 Hz located at the Cimeta river (Figure 2).

Based on SESAME[8], if the H/V curve contains high frequency, it may indicate very strong and close artificial ambient vibration sources and should be redone. We performed microtremor recording at two different times and places, first 60 m from the original location and the second 120 m from the original location with duration 25-30 minutes. To have only Rayleigh wave in HVSR we perceived particle motion of microtremor signal for determining the range of Butterworth bandpass filter. Range of Bandpass filter which indicated as Rayleigh wave particle motion is around 1 to 7 Hz. To eliminate
human activity noises, we used STA/LTA of 0.5 s / 30 s and also manually selected the noise based on observation of data acquisition. The result that we got from the new recording shown that fundamental frequency around the Cimeta river has a value between 9 to 11 Hz. Before the interpretation of the H/V curve, the curve needs to fulfill the standard of reliability and clarity peak of the H/V curve from SESAME[8]. We interpret the H/V curve obtained from the initial point to the newest point (Figure 3) has a reliable and clarity peak as type high-frequency clear peak.

We interpret high frequencies indicating as bedrock and area with shallow sedimentation because the area located at the valley and intersected by the Cimeta river. Furthermore, the Cimeta river correlates to the Lembang Fault system [1]. Therefore, we interpret that fundamental frequency obtained from microtremor signal recording is the characteristics of the Lembang fault segment Cimeta.

Figure 3. A, B and C are H/V curve generate from GEOPSY Software and indicate fundamental frequency around 9 – 11 Hz. A obtained at point 8 and recorded on the date of 25 June 2019, fundamental frequency around 10 Hz at this point. Meanwhile, image B obtained at point 39 and recorded 60 m from point 44 on the date of 30 July 2019. After analyzing the microtremor signal of point 39, we found another same value of fundamental frequency around the Cimeta river. To interpret more accurate, we recording another microtremor signal 120 m from the initial point, i
5. Conclusion
Microtremor signal recording was performed in Padalarang, Ngamprah and Bojokoneng area with a total of 37 point acquisition with duration around 25 to 30 minutes. The H/V curve generated from the microtremor data shows the area has characteristics of fundamental frequency around 1 to 6 Hz. Uniquely, we found an anomaly of high-frequency fundamentals around the Cimeta river. To have a better understanding of these anomalies, we performed another microtremor signal recording with the interval around 60 to 120 m from the initial point. From 3 microtremor recording around the Cimeta river, fundamental frequencies of the area have a value from 9 to 11 Hz. These high frequencies indicate shallow bedrock, which indicates characteristics of the Lembang Fault segment Cimeta.

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