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MICROTREMOR ANALYSIS IN DETERMINING LANDSLIDE POTENTIAL IN SEMBAHE VILLAGE, SIBOLANGIT DISTRICT, DELI SERDANG REGENCY

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ABSTRACT

Sembahe Village is an area that is highly vulnerable to landslides. This is caused by steep topographic conditions and high rainfall. This research is intended to understand the characteristics and distribution of dominant frequencies, amplification factors and seismic vulnerability index on the possibility of landslides. Microtremor measurements were carried out in Hamlet 3 Sembahe Village at 2 location points which were measured using a portable seismograph / Pegasus for 2 hours with a sampling frequency. 100 Hz. Microtremor data was processed using Geopsy software using the Horizontal to Vertical Spectral Ratio (HVSR) method and each parameter was weighted using the Analytical Hierarchy Process (AHP) statistical method in determining potential landslide areas. The results obtained show that the distribution of dominant frequency values (F0) is 5.36 Hz – 5.33 Hz, amplification (A0) is 1.84 – 1.59, seismic vulnerability index (Kg) is 0.63 x 10-3s2 / cm - 0.47 x 10-3 s2/cm. Based on weight analysis using the AHP statistical method, the location point that has the highest potential for landslides is point 1.

Keywords: Analytical Hierarchy Process, Microtremor, Landslide

INTRODUCTION

Landslide is a phenomenon where masses of soil rock move along a slope due to changes in slope stability (Hartantyo, 2021). Landslides occur when the slope force is greater than the restraining force, rock and soil density usually affect the pushing force, while water slope, load and rock soil density affect the pushing force, sembahe village is among the areas most vulnerable to landslides (Rachardi, 2018).

Sembahe Village, located in Sibolangit Sub-district, is thought to be at risk of landslides. This is due to topographic variations and diverse geological soils, as well as high rainfall, which can increase vulnerability to landslides. Based on the geological map, the study site falls under the category of the singkut Unit rock formation which includes andesite, dacite, microdiorite and tuff.

The impact of landslides is not only limited to physical damages such as offices, public facilities, agricultural land, plantations, and loss of life, but can also cause indirect damage to regional development and economic activities. Therefore, it is important to carry out disaster mitigation measures in dealing with this situation. (Afriani, 2020).

Disaster mitigation efforts are needed to reduce the possibility of landslides so that they can be overcome (Ayusari, 2021). Disaster mitigation measures include a better understanding of the causes, soil characteristics, increased community awareness and preparedness for landslide risk, and identification of vulnerable areas using geophysical methods such as microtremor method with Horizontal to Vertical Spectral Ratio (HVSR) and Analytical Hierarchy Process (AHP) statistical weighting analysis.

AHP is a method that takes into account both objective and subjective factors when ranking alternatives. In addition, AHP can support the decision-making process in hierarchical decision-making models (Permanajati, 2019).

RESEARCH METHOD

Microtremor data were collected using a pegasus type seismometer as many as 2 points for 1 day on 20 January 2024. Data collection location in hamlet 3 Sembahe Village located at geographical coordinates 3°21'50 'LU - 98°34'29.46 'LS. Each point was taken for 2 hours with a sampling frequency of 100 Hz.

The microtremor data were processed using Geopsy software using the Horizontal to Vertical Spectral Ratio (HVSR) method. This process includes filtration to reduce interference or noise, where the first 50 seconds of data from the beginning of the measurement is used. Correction was performed using Konno Ohmachi smoothing with a bandwidth of 40 and a taper using a cosine function of 5%. Frequency calculation was performed using the fast Fourier transform (FFT) method. After data processing, HVSR values were obtained for each measurement point.

The resulting HVSR curves provide values of dominant frequency (F0) and amplification (A0) for each measurement point. These A0 and F0 values are used as starting points to calculate other parameters, including the seismic susceptibility index (Kg).

The seismic susceptibility index (Kg) is calculated based on the squared ratio between the amplification value (A0) and the dominant frequency (F0) in the study area, as described in equation (1).

$$Kg=\frac{A0^2}{F0} \quad (1)$$

The results of all parameter values at the measurement points were then analysed using the Analytical Hierarchy Process (AHP) method to find areas with landslide potential.

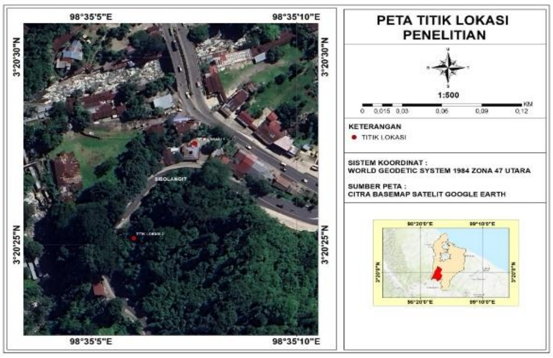

Figure 1. Research location

RESULT AND DISCUSSION

The results of microtremor analysis using the HVSR (Horizontal To Vertical Spectral Ratio) method are used to generate H/V curves showing the dominant frequency values and amplification factors, which will be used in the calculation of the seismic vulnerability index.

A. Point 1

From the results of the H/V curve drawing of research point 1, the frequency (F0) of 5.36072 Hz was obtained, the amplification value (A0) was 1.84549.

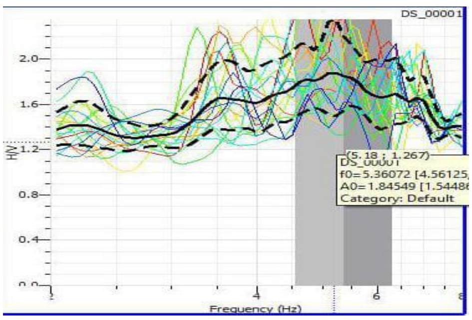

Figure 2. Research point 1

B. Point 2

From the results of the H/V curve drawing of research point 2, the frequency (F0) of 5.33243 Hz was obtained, the amplification value (A0) was 1.59597.

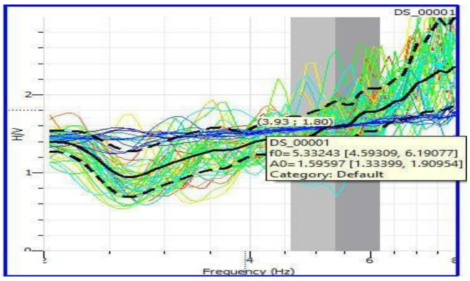

Figure 2. Research point 2

C. Dominant Frequency *(Fo)*

The dominant frequency is the frequency that often occurs, therefore it is called the natural frequency value possessed by the soil which indicates the type of soil or rock characteristics in a measurement area. The dominant frequency is obtained from the horizontal axis of the peak of the H/V curve.

Based on the data obtained from the dominant frequency classification, it is known that the soil conditions at the research points have rocks with medium to high strength levels and the amplification factor values obtained for each research point are included in the low category, namely A < 3 which has an amplification value of 0.81 < 1.15. This is in accordance with the classification put forward by Nakamura (2000).

D. Amplification Factor

Amplification is an increase in the size of seismic waves that occurs due to significant differences between layers within the earth. When seismic waves travel from a denser medium to a softer medium, they will experience a large increase. The greater the difference in wave propagation parameters such as density and velocity between the two layers, the higher the amplification value. Based on the data obtained from the classification value of the amplification factor, it is known that the soil conditions at the research points have rocks with medium to high strength levels and the amplification factor values obtained for each research point fall into the low category of A < 3 which has an amplification value of 0.81 < 1.15. This is in accordance with the classification put forward by Nakamura (2000).

E. Seismic susceptibility index

The seismic vulnerability index is a measure that reflects how susceptible the soil layers are to earthquakes. It is calculated by dividing the amplification factor value by the dominant frequency value. The seismic susceptibility index level is directly correlated with the amplification factor, meaning that the higher the amplification factor, the higher the seismic susceptibility index value. Based on the data obtained from the seismic susceptibility index classification values, it is known that the soil conditions at the research points are quite strong and the impact of damage in the event of a landslide is very small, this is because the seismic susceptibility value obtained at each research point is very small and is included in the low zone.

F. Landslide potential using AHP method

Tabel 1. Alternative ranking results using AHP method

Alternatif	Frekuensi Dominan	Faktor amplifikasi	Indeks kerentanan seismik	Resiko Longsor	Rangking
Alternatif	**0,18**	**0,27**	**0,55**		
Titik 1	0,5	0,54	0,57	0,55	1
Titik 2	0,5	0,46	0,43	0,45	2

Based on the results of the weighting analysis using AHP statistical method from all analysis parameters, it is known that the greatest landslide risk value is located at point 1 which has a value of 0.55.

CONCLUSION AND SUGGESTION

The results of the calculation and weighting using the Analytical Hierarchy Process method show that the values of analytical parameters such as dominant frequency, amplification factor, and seismic vulnerability index are located at point 1 of the study site which has a landslide risk value of 0.55.

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