ISSN (Print) : 2337-9030 ISSN (Online) : 2685-2608
PILLAR OF PHYSICS
Vol. 13 (2), 2020, page. 150-155
DOI : http://dx.doi.org/10.24036/9104171074

ANALYSIS OF GROUND SHEAR STRAIN (GSS) DISTRICT KAWALU TASIKMALAYA WITH HVSR METHOD USING MICROTREMOR DATA

Muhammad Reza Iswara[1], Syafriani[1*], Thomas Hardy[2]

[1] *Department of Physics, Faculty of Mathematics and Sciences, Universitas Negeri Padang, Jalan Prof. Dr. Hamka, Air Tawar Barat, Padang, West Sumatera, 25171, Indonesia*
[2] *Badan Meteorologi Klimatologi dan Geofisika*

Corresponding author. Email: syafri@fmipa.unp.ac.id

ABSTRACT

Tasikmalaya is one of the areas affected by the earthquake. One of efforts to reduce the impact of the earthquake is by analyzing seismic hazard levels as one of the earthquake disaster mitigation efforst with the microtremor method. It can determine the amplification value and the dominan frequency. From the dominant frequency value and amplification can be calculated. Seismic vulnerabilities index (Kg) and value of Ground Shear Strain (GSS). From the value of vulnerability index (Kg) and ground shear strain (GSS) can be known how much the level of vulnerability of the area to earthquakes. Furthermore, a spatial description of the distribution map of the seismic vulnerability index (Kg) and the ground shear strain value distribution map (GSS) were made in Kawalu Subdistrict, Tasikmalaya City. The dominant frequency value is obtained from 0.6 Hz to 16.7 Hz. The seismic vulnerability index (Kg) from Kawalu Tasikmalaya ranges from 0.2 to 20, and the GSS value from the low is 0.17 in the village of Urug to the highest of 12.13 in the village of Leuwiliang. This allows Kawalu Subdistrict to get a deformation phenomenon such as liquefaction, landslides when earthquake.

Keywords : Microtremor, Ground Shear Strain, HVSR, Earthquake.

I. INTRODUCTION

Tasikmalaya is one of the areas affected by the earthquake. An earthquake is a natural phenomenon in the form of waves with small or large power that can cause major or minor damage to infrastructure. To overcome and reduce the impact of the earthquake is to know the analysis of the hazard level of seismic vulnerability. This seismic hazard level analysis activity is an effort to reduce the impact of an earthquake. The way to determine the seismic hazard level of an area is by knowing the value of the distribution of the seismic susceptibility index (Kg) indicator and the ground shear strain (GSS) value obtained from microtremor data processing using the HVSR method..

Earthquake mitigation is a concept of initial planning and modeling of disaster mitigation that must be realized so that the risk of earthquake impacts is reduced. This modeling form is to know the identification of value analysis (Ground Shear Strain). The results of the GSS analysis illustrate the ability to stretch and shift the soil layers when an earthquake. GSS is also applied to determine the effects caused by earthquakes including landslides, liquefaction, subsidence and shaking of the ground. Analysis of this GSS can be done by analyzing the Microtremor data of an area.

Distraction from artificial nature such as wind, sea waves, traffic and industrial machinery cause weak ground vibrations or so-called microtremor [1]. The way to determine the GSS value is by conducting microtremor data research using the HVSR (Horizontal to Vertical Spectral Ratio) method. An overview of the dynamic characteristics of the soil is shown from the results of the dominant frequency (f0) and the value of the amplification factor (A0) through HVSR analysis [2].

Research with microtremor data is useful for analyzing the characteristics of the soil layer with the results of the analysis of the dominant period and the amplification factor. The frequency that often appears obtained from the HVSR curve is called the dominant frequency which is the frequency of the rock in the area. Through this frequency, it can describe the characteristic shape and rock type in the research area. The result of the dominant period is the one time reflection of the plane of reflection to the surface based on the time. The value of the dominant period can indicate the shape of rock characters in an area [3].

Vulnerability is a condition that is determined by a factor or process of physical, social, economic, environmental, cultural, educational, legal, political, technical and institutional processes that can lead to a disaster even though some have direct and indirect effects [4].

The seismic susceptibility index is an index that describes the level of vulnerability of the surface soil layer to deformation during an earthquake. In determining the value of the sesmic vulnerability index of an area, factors in the geological condition of the local area need to be considered. A high level of soil susceptibility index is usually found in areas with low resonant frequencies.

The value of the seismic susceptibility index is highly dependent on the dominant frequency (f_0) and the amplification factor (A_0) which is calculated from the seismic vibration spectrum [5]. The results of the seismic susceptibility index are obtained by squaring the peak value of the microtremor spectrum divided by the resonance frequency [6]. Nakamura's formulate:

$$Kg = A_0^2 / f_0 \qquad (1)$$

Kg = seismic vulnerability index value
A_0 = amplification value
f_0 = dominant frequency value(Hz)

The results of the Ground Shear Strain (GSS) in an area estimate the potential for the soil layer to shift and move due to the impact of the earthquake. The relationship between GSS and potential disasters caused by land is shown in Table 1. When the GSS value shows 1000 × 10^{-6}, then the soil begins to show non-linear characteristics and if the GSS value is more than 10.000 × 10^{-6}, then the soil can potentially experience deformation and collapse [6]. GSS value can ba calculated by Nakamura's formula :

$$\gamma = Kg \; x \; \alpha(10^{-6}) \qquad (2)$$

ɣ = the value of GSS (GSS)
α = peak ground acceleration (gal)
Kg = seismic vulnerable value

Table 1. Connection Between Dynamic Character of Soil and GSS

Strength value ɣ	**10^{-6} 10^{-5}**	**10^{-4} 10^{-3}**	**10^{-2} 10^{-1}**
Phenomenon	Waves, Vibrations	Crack, Land subsidence	Landslides , Land subsidence, liquifaction
Character Dynamic	Elastic	Plastic elastic	Collapse
		Repeat effect, speed effect of charge	

II. METHOD

Data collection is data in the form of measurement of microtremor signals directly in the district Kawalu Tasikmalaya city obtained from research data Puslitbang BMKG, measurements are carried out for 30 minutes for each point with a sampling frequency of 100 Hz.

The research began with the processing of microtreor data using HVSR geopsy software that aims to obtain f_o and Ao values. The result of analysis by HVSR method will produce a graph between H/V and frequency. Soil amplification factor obtained from the value of H / V max on the dominant frequency (f_o) which is then the value is inputted into the formula Kg so that the value of Kg is obtained.

Ground shear strain (GSS) values are required for soil acceleration niali (α) and seismic vulnerability index (Kg) values. After that, the analysis of earthquake effect insecurity level of ground shear strain (GSS) value and seismic vulnerability index (Kg) value. Furthermore, spatial depictions are carried out by creating microzonation maps from the district Kawalu Tasikmalaya using the value of the parameters obtained. Flowcharts from the study are shown in Figure 1.

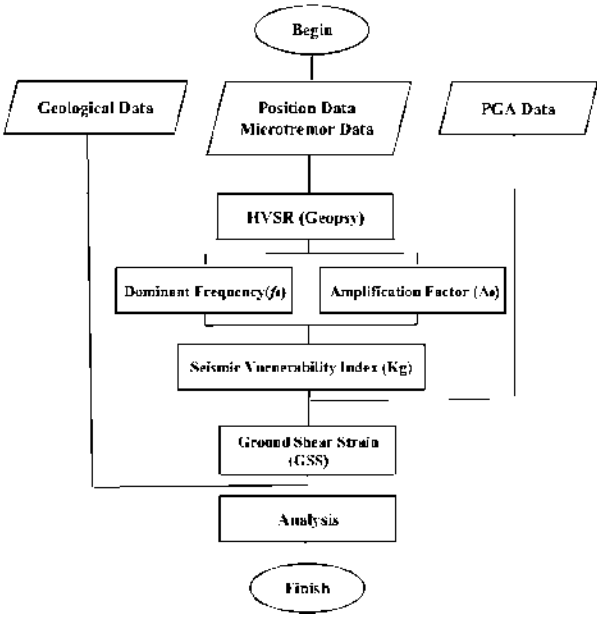

Fig.1. Flowcharts

In Figure 1. it can be seen that from microtremor data analyzed to obtain HVSR or ordinary graphs also using HVSR analysis contained *in Geopsy software.* From the analysis, the dominant frequency value(f_0)and amplification factor value (A_0)are used to calculate seismic vulnerability value (Kg) as input data.

Furthermore, to find out the GSS (γ) value we can use the value of the Seismic Vulnerability Index (Kg) obtained by the soil acceleration value (PGA) of the research area. The phenomenon that occurs can be estimated from the connection between the strain and the dynamic nature of the soil based on the value of GSS (γ) in Table 1 .After microzonation was obtained, it was connected with geological data of The District Kawalu Tasikmalaya for modeling using arcgis program

III. RESULTS AND DISCUSSION

The results of this study were presented in the form of distribution map of GSS analysis as a result of HVSR analysis of microtremor measurement data in Kawalu District of Tasikmalaya City. There are three components in microtremor data, namely horizontal N-S (North-South), horizontal E-W (East-West), and vertical components. The recording data format is *.trc which is then saved in *format. MSD (miniseed) using DataPro.Pemilhan signal without noise is done by using Sessary Geopsy application through windowing and cutting process.. Figure 2. Here is an example of microtremor data measurement results in the field.

.

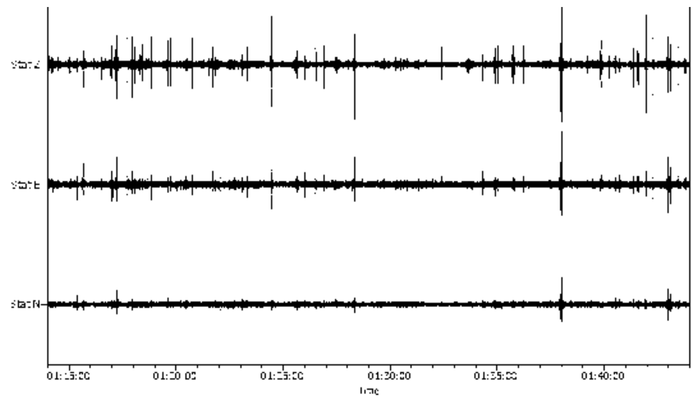

Fig. 2. Microtremor signal

The use of HVSR method for microtremor data processing begins by selecting stationary windows on spectrum components. Then Fourier spectrum funding (FFT) is performed to convert the signal into the frequency domain in each window. To refine the FFT results, we use KonnoOhmachi smoothing filter with a bandwidth coefficient of 40. Horizontal component data is combined through an average count of the spectrum of each component, so that the horizontal part data is divided by vertical components in the frequency domain so that the H/V value for each window is obtained. Then, the H/V value of each component for all windows is averaged so that the average curve of H /V. After the H/V curve is obtained there can be obtained the value of amplification factor (A_0) and dominant frequency value (f_0) in Figure 3.

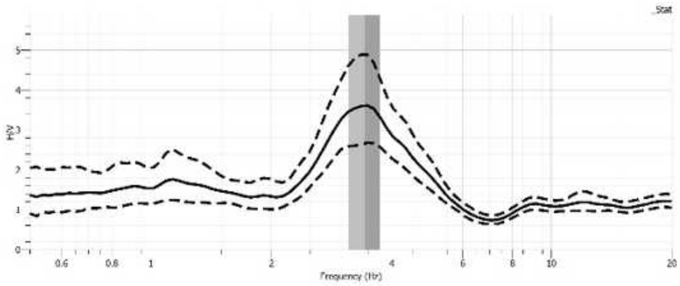

Fig. 3. HVSR curve

From the results of the study obtained the dominant frequency value of District Kawalu Tasikmalaya ranging from 0.1 Hz to 17 Hz,and for the value of amplification factor ranging from 1.4 to 6.1 From squelifying the value of amplification factor divided by the dominant frequency value of each point obtained seismic vulnerability index value Of Kawalu District Tasikmalaya City. The calculation results obtained the value of the seismic vulnerability index kawalu district ranging from 0.28 - 20.2 presented in the form of a map as in Figure 4.

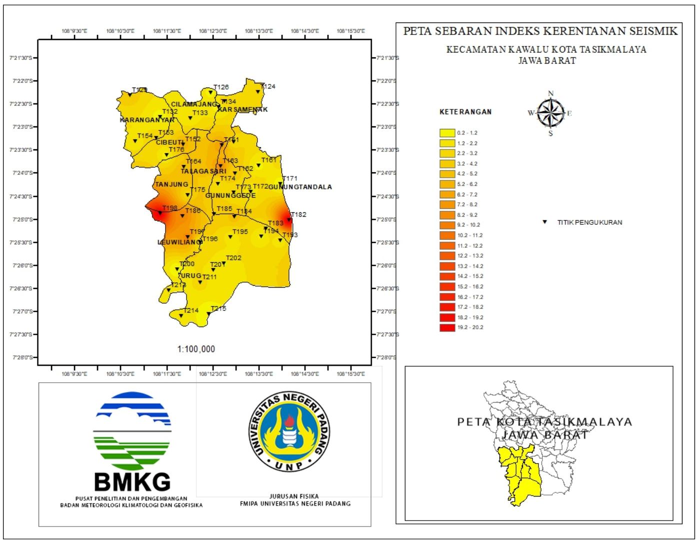

Fig. 4. Distribution map seismic vulnerability index district Kawalu Tasikmalaya City.

To find out the size of the GSS value, a multiplication is performed between the seismic vulnerability index value based on microtremor and the amount of PGA value in the base stone. The results of calculation and analysis of values can be seen in Figure 5.

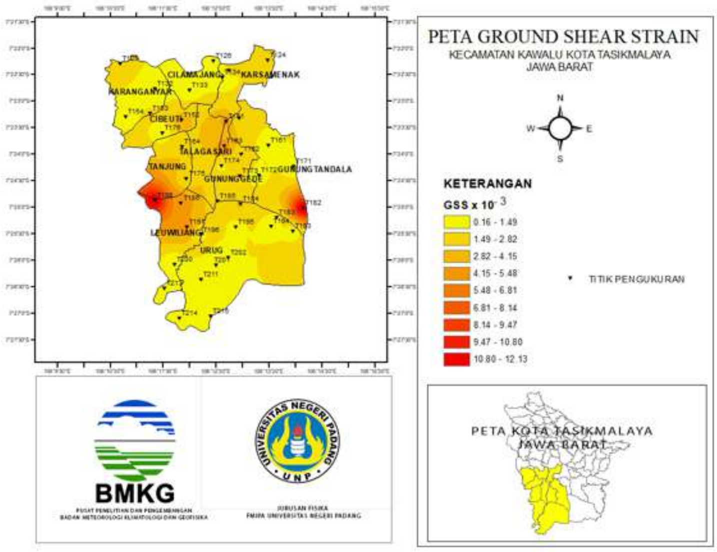

Fig. 5. Distribution map value GSS District Kawalu Tasikmalaya City.

From the results of the analysis obtained the value of seismic vulnerability index kawalu district ranging from 0.28 - 20.2. For high seismic vulnerability index value, namely in the southwestern part of Tanjung village, northwest area of Leuwiliang village, and in the northeastern part of Gunungtandala village. This indicates that this area is the region that dominates the most against the effects of earthquakes. For areas with low vulnerability value, namely in karanganyar village and southern Urug village. The lower the Kg value indicates that the area has solit sediment. The greater the kg value of an area, the greater the level of damage caused by the impact of earthquakes, the lower the value of Kg, the smaller the potential damage caused by earthquakes.

The result of GSS calculation predicts the possibility of an area experiencing potential damage due to earthquakes, while the understanding of GSS itself is the ability of layers to stretch and shift due to the impact of earthquakes. Therefore, analysis of GSS value is necessary. The greater the value of GSS has the potential to cause damage to an area as a result of an earthquake and if the value of GSS is lower, then the lower an area has the potential to experience damage caused by an earthquake. Based on the table of soil dynamic properties classification relationship with GSS at the time the GSS value indicates a value of 10^{-6} –10^{-5} will experience waves and vibrations, and if the GSS result shows 10^{-4} -10^{-1} there will be a crack; soil decline; landslides; to liquefaction.

The calculation results showed the *amount of Ground Shear Strain* (GSS) in Kawalu subdistrict ranging from $1.6x10^{-4}$ to $12.13x10^{-3}$. To determine what phenomenon occurred in District Kawalu Tasikmalaya city we connect the value of GSS with Table 2. The dynamic nature of the soil with the GSS value. The calculation results showed the *amount of Ground Shear Strain* (GSS) in Kawalu subdistrict ranging from $1.6x10^{-4}$ to $12.13x10^{-3}$. This predicts that in Kawalu subdistrict during earthquakes with strong shocks will allow the soil to experience liquefaction, soil decline, deformation, and collapse.

Nakamura drr. has also stated the same in his research in the Marina District of San Francisco. Severe damage occurred in the Marina District when an earthquake struck Loma Prieta in 1989. The area around the coast that is an alluvium deposit is severely damaged because it has a high seismic susceptibility index. After entering the harder rocky hills, the seismic vulnerability index value changes to a smaller [7].

IV. CONCLUSION

Based on the results of the research and the wetting carried out, the conclusions are:

1. The amount of GSS value of Kawalu District of Tasikmalaya City obtained by HVSR Method ranges from $1.6x10^{-4}$ to $1.2x10^{-2}$, with the highest GSS value in leuwiliang, Tanjung, and Gunungtandala villages.
2. The phenomenon that may occur in The District Kawalu Tasikmalaya city based on the value of GSS range 10^{-4} - 10^{-3} is deformation such as liquefaction, landslides, and landslides.

REFERENCES

[1] Motamed, R. Ghalandarzadeh, A.,T awhata, I. & Tabatabe, S.H. *Seismic Microzonation and Damage Assessment of Bam City. SouthernIran*: Journal of Earthquake Engineering. 11:1, 110-132. 2007.

[2] Nakamura, Y. *Clear Identification of Fundamental Idea of Nakamura's Technique and Its Application*. Japan: Tokyo University. 2000.

[3] Arifin, A.S., Mulyatno, B. S., Marjiyono & Setianegara, R. *Penentuan Zona Rawan Guncangan Bencana Gempa Bumi Berdasarkan Analisis Nilai Amplifikasi HVSR Mikrotremor Dan Analisis Periode Dominan Daerah Liwa Dan Sekitarnya*. Lampung: Universitas Negeri Lampung. 2013.

[4] Pawirodikromo, W. Seismologi Teknik dan Rekayasa Kegempaan, Pustaka Pelajar, Yogyakarta. 2012.

[5] Nakamura, Y. *Clear Identification of Fundamental Idea of Nakamura's Technique and Its Application*. Japan: Tokyo University. 2000.

[6] Nakamura, Y. *Seismic Vulnerability Indices for Ground and Structures Using Microtremor*. Florence: World Congress on Railway Research. 1997.

[7] Nakamura, Y., Sato, T., dan Nishinaga, M. *Local Site Effect of Kobe Based on Microtremor Measurement*, Proceeding of the Sixth International Conference on Seismic Zonation EERI, Palm Springs California. 2000.