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STUDY OF SEISMIC HAZARD LEVEL BASED ON MICROTREMOR MEASUREMENT ANALYSIS IN KOTO TANGAH DISTRICT, PADANG CITY

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ABSTRACT

The city of Padang is tectonically one of the areas with very high seismic activity in Indonesia. Therefore, we conduct a study to determine the level of seismic hazard using analysis of microtremor measurements in the sub-district of Koto Tangah, Padang City, as well as micro-zoning the distribution of the dominant frequency value, amplification value, dominant period, and seismic vulnerability index. The type of research is descriptive research, namely by taking microtremor data using a sysmatrack MAE seismograph and S3S sensor in Koto Tangah sub-district, Padang city. Microtremor data processing uses geopsy software to remove noise data and see the dominant frequency and amplification values. From the results obtained, the gypsy software then made a contour mapping of its value using the surfer 13 application and microzonation mapping. The results obtained from this study in the Koto Tangah sub-district, Padang City, are areas that are vulnerable to seismic hazards whose data can be seen from the distribution of the micro zonation value of dominant frequency (f0), amplification factor (A0), dominant period (T0), and seismic vulnerability index value. (Kg) is included in the medium to high category due to the influence of underground geology.

Keywords; ***Microtremor, Microzonation, Seismic Hazard***

I. INTRODUCTION

Padang city is located 250 km east of the Sumatran subduction zone, which was formed by the collision of the Indo-Australian plate under the Eurasian plate with an average speed of 50-70 mm/year. The city of Padang is tectonically one of the areas with very high seismic activity in Indonesia. In addition, the city of Padang is a very earthquake-prone area due to the movement of the Sumatran fault, which stretches along the Bukit Barisan Mountains from Semangko Bay to Aceh[1]

Earthquakes themselves often occur on a large or small scale. The number of earthquakes cannot be separated from the active tectonic conditions. In addition, there are also active fault lines and a series of active volcanoes in the subduction zone. The subduction zone occurs due to the movement of the India-Australia tectonic plate, which moves to the northeast and subducts the Eurasian plate. This causes the two plates to push against each other slowly and create tension. If the stress generated is more significant, the scale will gradually collapse. The meeting of these two plates has oblique subduction at a speed of 5-6 cm/year.

Based on the Koto Tangah sub-district's geological conditions and increasing development conditions, it is necessary to anticipate and treat early in terms of conducting an initial survey to determine the level of seismic hazard risk in the area. To assess the level of seismic hazard risk in a room, microzonation of areas prone to seismic activity can be carried out using the microtremor microzonation method. Microtremor is a vibration of tiny amplitude that occurs continuously from soil or rock structures caused by subsurface biological activities or human activities such as traffic, people walking, and others. This method is considered easier and cheaper to implement so that disaster-prone areas and earthquake planning can be made in a short time[2]

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Microtremor microzonation has been carried out in many previous studies, including Reza [3]in Kejawan Putih Village, Tambak Surabaya, by dividing earthquake zones using the HVSR method. In this study, the natural frequency values ranged from 1.00 to 2.65 Hz, the amplification factor was between 2.19-8.04, the vulnerability index was between 3.25 - 58.81, and the sediment thickness was between 23.73-107.52 m. . In addition, a study on the potential for earthquake hazards based on local site effects has also been carried out by Bambang ([4]in the Sumbawa area. This research was conducted to determine the dynamic characteristics of local geological conditions. Measurements were carried out for 30 minutes at each measurement point.

Based on the research that has been done, it can be concluded that based on microtremor measurements, microzonation of earthquake-prone areas can be carried out, both in the regions that have a local footprint effect from earthquake events that have occurred in the area. The HVSR method compares the spectrum ratio of the horizontal component of the microtremor signal to its vertical part[5]. Therefore, a study was conducted using the HVSR microtremor method. The research that will be shown in the sub-district of Koto Tangah, the city of Padang, will focus more on how high the seismic hazard level in the area is due to the influence of the geological conditions of the site based on the analysis of microtremor measurements. This study aims to determine the level of seismic hazard based on the analysis of microtremor measurements in the district of Koto Tangah, the city of Padang, and make a microzonation map. The benefit of this research is to inform the public about the dangers of seismic activity and the distribution map of the zoning of areas prone to seismic hazards. The following is a geological map of the city of Padang in Figure 1

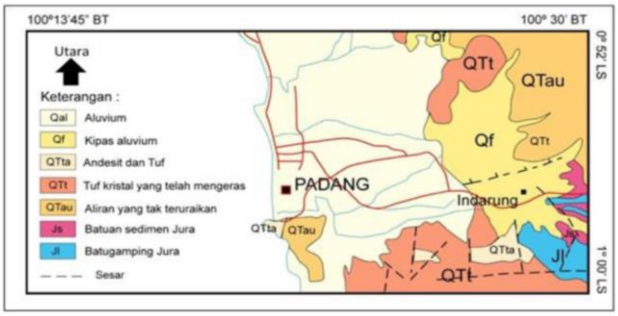


Fig 1. Geological map of the city of Padang and its surroundings [1]

Based on the figure 1 geological map of the city of Padang , the area of the city of Padang is composed of 4 (four) rock layers consisting of Jurassic sedimentary rocks and volcanic rocks of quarter age. The old sedimentary rock consists of limestone (JI) and metamorphic sediment (Js). Volcanic rocks consist of tuffeditic and basaltic, breccia (QTt), and lava (QTau). These rocks are found in the southern and eastern hilly areas. Younger volcanic rocks (Qf) are composed of andesite debris from Qtau volcanic rocks found on the slopes of quarter volcanoes east of the hilly region. The youngest rocks in the Padang City area are quarter alluvial deposits (Qa), consisting of sand, lakes, gravel, and thick layers of sediments. These deposits form an alluvial plain from the foothills with a width of 10 km in the west-east and 20 km in the north-south direction[1]

Koto Tangah sub-district is a sub-district in Padang City, West Sumatra Province. The district this located at 00°58 south latitude and 99°36'40"- 100°21'11" east longitude. Based on its geographical position, this sub-district has regional boundaries, namely to the north, it is bordered by the Padang Pariaman Regency, to the south, to the North Padang District, and Nanggalo Sub-district, to the west of the Indian Ocean, to the east of Solok Regency. This sub-district has an area of 232.25 km2, located 0-1,600 meters above sea level, with rainfall of 384.88 mm/month.

Seismic microzonation can be regarded as estimating the response and behavior of the soil layer or sediment to an earthquake. Meanwhile, microtremor is a minimal and continuous vibration (vibration) from the ground or structure caused by artificial activities such as traffic, people walking, factory machinery, and others. The amplitude is tiny, only in the range from 0.1 to 1.0, and the period is from 0.1 seconds to 1.0 seconds[6]

Seismic microzonation or microtremor microzonation is a process of dividing areas that can potentially damage due to seismic and earthquake activities by considering the geological and geographical characteristics of the sediment layers. The factors considered include ground shaking, susceptibility to collapse, ground motion, and so on [7]

Microtremor surveys can be carried out in two ways. Namely, the first approach is recording simultaneously at two or more locations. One of the recording sites must be carried out in complex rock areas so that it does not show any frequency gain due to ground motion. The spectrum ratio obtained in other places will be compared with those recorded on a hard rock to get the site response to microtremor. The second approach was introduced by [8], along with his analytical method. Nakamura found that the ratio of the horizontal and vertical spectra of microtremor increases at the resonant frequency and will show a peak at that frequency. Nakamura assumed that H/V reflected the amplification factor level of the ground motion. With this method, measurements do not need to be carried out under the condition that hard rock is present [8]

In general, the recording of microtremor is no different from recording seismic waves on a seismometer. The instrument used is a seismometer. For the Nakamura method, a seismometer is needed, which has three components that record the EW (East-West), NS (North-South), and vertical (Up-Down) components. Microtremor recording does not require an artificial source or a source in the form of an earthquake, but direct measurements are made because what is recorded is a wave that arises from nature[9]. Ambient noise spectra obtained from microtremor measurements can be used to determine the location response, mainly the frequency of the central peak or the resonance frequency of the sediment layer. Location response in sedimentary areas is closely related to sediment thickness and shear wave velocity, so the location response obtained from the spectra comparison technique can be used to determine sediment thickness. Microtremor studies have been widely used to estimate the damage caused by earthquakes. This study is exact and suitable for assessing the level of risk caused by seismic activity with local geological conditions [8]

Microtremor is a natural harmonic vibration of the soil that occurs continuously[5] with a low amplitude of about 0.1 - 1 micron produced by subsurface movements. Microtremor characteristics reflect the characteristics and types of rocks based on their dominant period values. They help analyze rocks' response to amplifying (amplifying) vibrations based on the impedance difference between the basement and the overlying sedimentary rock [9].

The ability of the HVSR technique to provide reliable information associated with local effects exhibited rapidly correlated with HVSR parameters characterized by low natural frequency (high period) and high amplification factor[2]. So estimating the frequency, attenuation, and vulnerability index of building vibrations from small amplitude excitations is considered accurate and stable. The use of microtremor itself has been widely carried out to identify the essential frequency resonance of the building and the soil structure below it. The critical parameters resulting from the HVSR method are natural frequency and amplification. The measured HVSR on the soil aims for local geological characteristics, natural frequencies, and amplification factors related to subsurface physical parameters [10].

II. METHOD

This research is a type of descriptive research, where the data used in this study is primary data taken from the results of research conducted in the field in the district of Koto Tangah, Padang City. In this study, eight measurement points were taken that spanned the Koto Tangah sub-district, Padang City, where the distance between the points ranged from ± 500 m.

The tools used for this research are seismograph sysmatracht MAE and sensor s3s. Where the support for this tool is a GPS and a laptop/computer, this tool works with a system of recording signals recorded on the soil/layer. The measurement results are displayed on data pro software, cannot be directly processed using geopsy software, and must be converted to trace format (*trc). Data in trace format is converted to the diminished format. After being converted into diminished data format, it can be processed using geopsy software. The data obtained from geopsy software using the HVSR method are the dominant frequency value (f0) and amplification factor (A0). These parameters are entered into equation 6 to obtain the value of the prevailing period (T0) and equation 5 to calculate the value of the seismic vulnerability index (Kg). Next, make a contour of the distribution of values from the dominant frequency (f0), dominant period (T0), amplification factor (A0), and seismic vulnerability index (Kg) using Surfer 13 software. From these contours, a microzonation mapping of the area is then made by overlaying the shapes of the distribution of the values of each parameter with a geological map that has been digitized previously and then inputted into the Google Earth software. Then input again to surfer 13.

Data analysis was carried out by looking at the dominant frequency value (f0) and the amplification and amplitude values. The principal frequency value is usually set by setting the standard deviation so that the frequency value is not too high, causing measurement errors. From the results obtained, it is possible to determine the level of seismic hazard risk based on the analysis of microtremor measurements in the Koto Tangah sub-district, Padang City. The purpose of this microtremor data processing is to determine how significant the risk of seismic hazard around the measurement point is by matching the scatter values of each parameter with the soil conditions and geological condition of the area around the exchange point.

III. RESULTS AND DISCUSSION

The results of this study will later be presented in the form of mapping the dominant frequency, amplification factor, dominant period, and seismic vulnerability index, which will also be made a research microzonation mapping in Koto Tangah sub-district, Padang city. This research will produce microtremor data using geopsy software to select a signal without noise. And later, an analysis of the seismic hazard will be carried out.

There are three components in the microtremor data: the horizontal component N-S (North-South), the horizontal component E-W (East-West), and the vertical component([8]The recording data format is in the form of trace(*trc), which is then stored in minimized format (*MSD) using DataPro software. Microtremor data were analyzed using geopsy software by windowing and cutting for signal selection without noise. The following in Figure 2 is the measurement data at point 1.

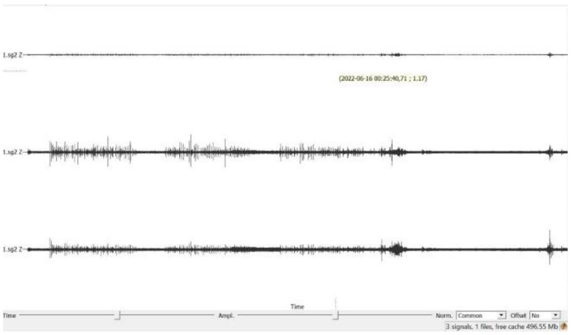


Fig 2. Measurement data at point 1

The data obtained in Figure 2 above will refine the signal results using a smoothing Konno Ohmachi filter with a bandwidth coefficient of 40. Horizontal component data (N-S and E-W) are combined by calculating the average spectrum of each component so that the H component is obtained. Flat component data is divided by the vertical element in the frequency domain so that the H/V value is obtained for each window. Then, the H/V value of each component is averaged, and the average H/V display can see in Figure 3.

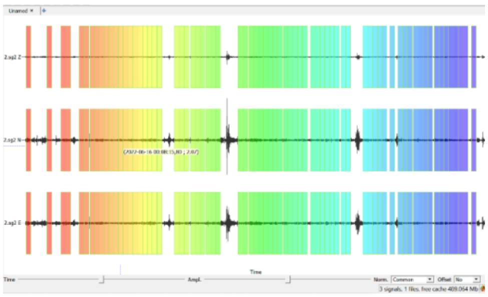
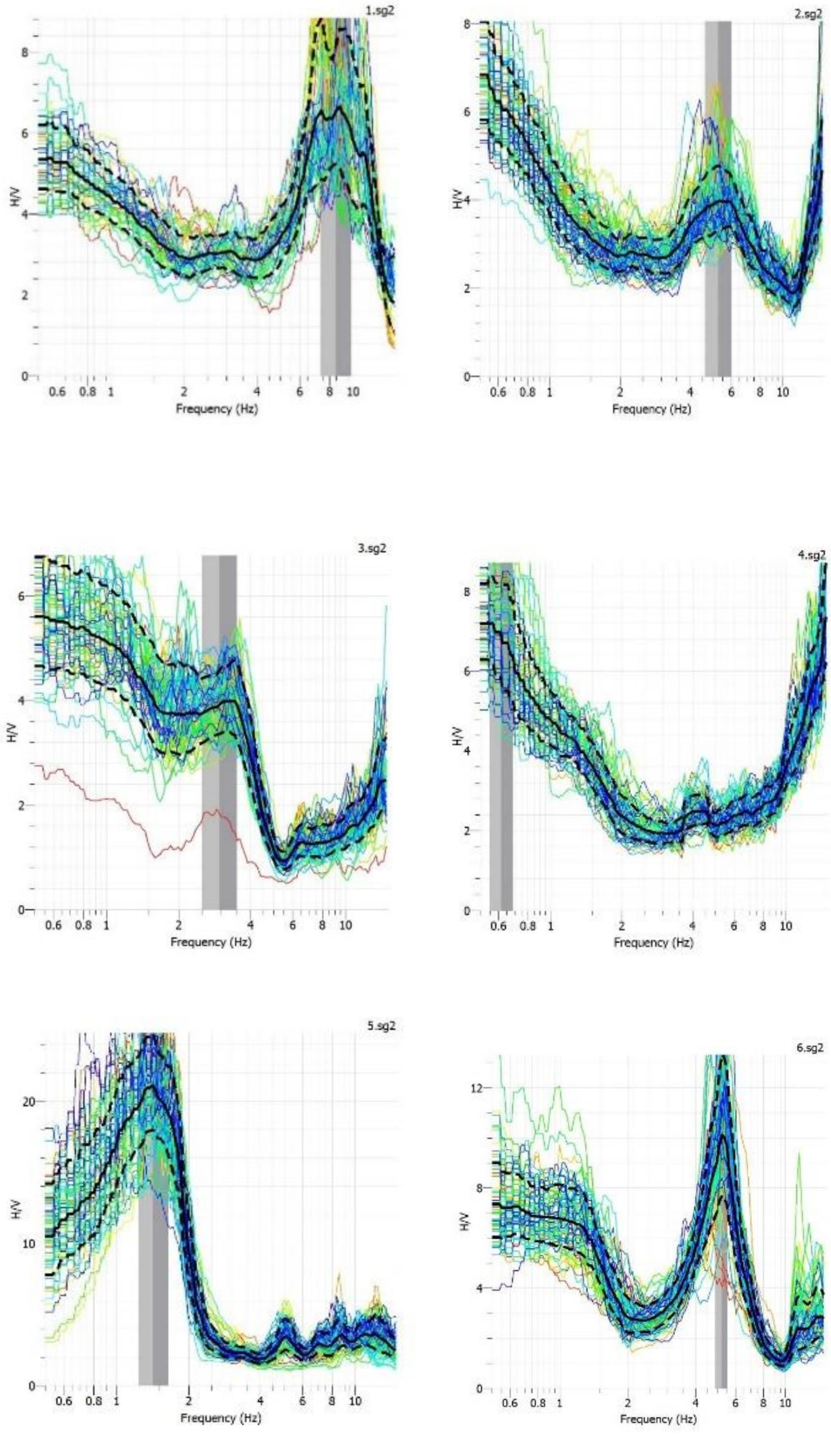


Fig 3. point 1 microtremor HVSR display

Based on figure 3 above shows that it is a microtremor HVSR display where the display is a signal display recorded in the time window.Microtremor data processing using the HVSR method begins with selecting a stationary window on each spectrum component. Then performed, Fourier spectrum analysis (FTT) to change the signal in the form of a frequency domain in each window. To refine the results of the FTT used, a smoothing filter Konno Komachi bandwidth coefficient of 40 using[10]. The horizontal component data (N-S and E-W) are combined by calculating the average spectrum of each component so that the flat part (H) is obtained. Horizontal component data is divided by vertical component data in the frequency domain, so H/V values are obtained for each window. Then the H/V value of each component for all windows is averaged to get the average H/V curve. The following figure 4 is an HVSR graph of point 1 microtremor data.


1.sg2
2.sg2
3.sg2
4.sg2
5.sg2
6.sg2
H/V
Frequency (Hz)

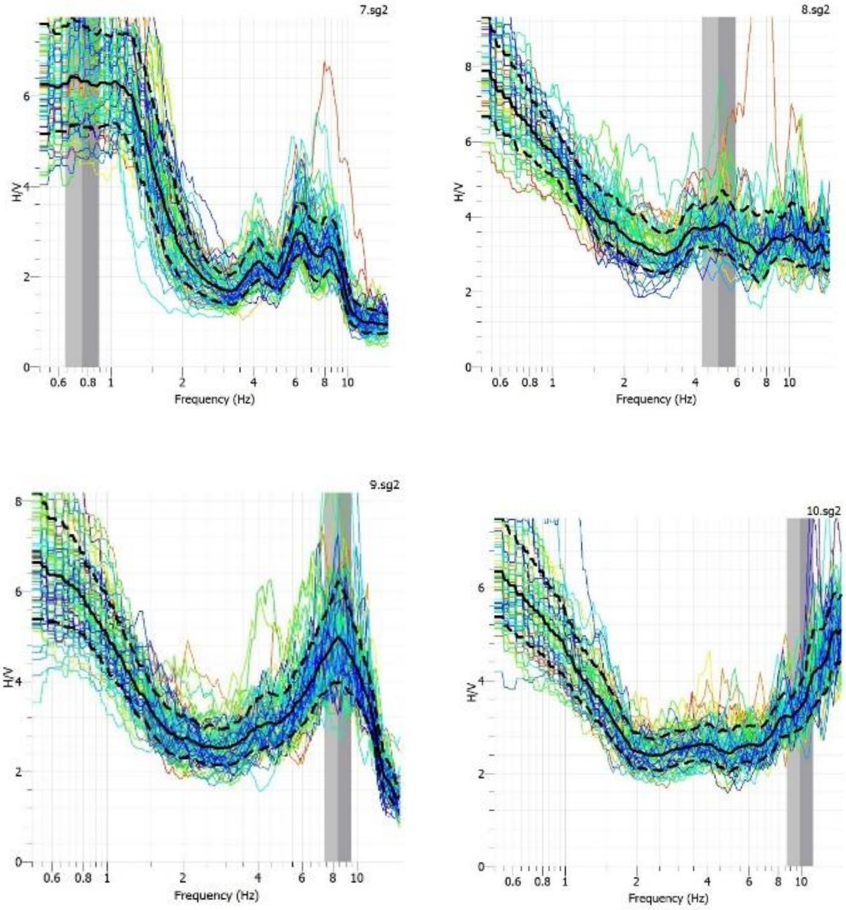


Fig 4. (a) HVSR graph of 1 point microtremor data, (b) HVSR graph of 2 point microtremor data, (c) HVSR graph of 3 point microtremor data,(d) HVSR graph of 4 point microtremor data, (e) HVSR graph of 5 point microtremor data, (f) HVSR graph of 6 point microtremor data, (g) HVSR graph of 7 point microtremor data, (h) HVSR graph of 8 point microtremor data, (i) HVSR graph of 9 point microtremor data, (j) HVSR graph of 10 point microtremor data

Based Figure 4 above shows the HVSR graph of microtremor data at each point. The graphs above show each topic's dominant frequency value (f0). At point 5 is 1.42 Hz, point 4 is 0.614 Hz, point 7 is 0.75 Hz, point 3 is 2.96 Hz, point 8 is 5.02 Hz, point 6 is 5.2 Hz, point 2 is 5 .27 Hz, point 9 is 8.36 Hz, point 1 is 8.43 Hz, point 10 is 9.86 Hz. Meanwhile, the amplification value (A0) at point 5 is 21, at point 6 is 10.04, at point 4 is 6.89, at point 1 is 6.51, at point 7 is 6.33, at point 9 is 4. .97, at point 2 is 3.96, at point 3 is 3.91, at point 8 is 3.77, at point 10 is 3.39.

Seismic hazard analysis was carried out using several parameters, namely dominant frequency (F0), dominant period (T0), seismic susceptibility index (Kg), and amplification factor (A0). The results of the analysis can be seen as follows:

For the dominant frequency, the high vulnerability category is found at the measurement points point 4, point 7, and point 5, with the principal frequency value being at a vulnerable value of < 2.5 Hz. Where connected to the soil classification table based on the frequency value of microtremor by Kanai [3]it this known that the frequency value obtained from the data processing is classified as soil type IV with soil classification in the form of alluvial rock formed from delta sediment, topsoil, mud with a thickness of 30 meters or more (the thickness of the surface sediment is very thick). The vulnerability category for the dominant frequency value is currently located at point 3, with the principal frequency value being 2.5-4 Hz. Suppose it is connected with the Kanai soil classification table [3]In that case, it is known at point 3 that the frequency value obtained from the data processing results is classified as type III soil with soil classification in the form of alluvial rock with a thickness of > 5 meters. It consists of sandy gravel, hard sandy clay, and loam, with a surface sediment thickness of about 10-30 meters. For the dominant frequency value, the low vulnerability category this found at the measurement point of point 8, point 6, point 2, point 9, point 1, and point 10, with the dominant frequency value being in the range of 4-10 Hz. Suppose it is connected with the Kanai soil classification table [3]. In that case, it is known that the frequency value obtained from the data processing results classified as type II soil with soil classification in the form of alluvial rock with a thickness of 5 meters. It consists of sandy gravel, hard sandy clay, and loam, with a thickness of the surface sediment in the medium category of about 5-10 meters. Following are the results of the data analysis of the dominant frequency values for each measurement point

Table 1. Results of data analysis of dominant frequency values (f0)

Point Name	longitude X(m)	latitude Y(m)	elevation angle z(m)	Dominant frequency f0	Vulnerability Category
POINT 4	646399.00	9908975.00	113	0,614	TALL
POINT 7	646829.00	9909165.00	256	0,75	
POINT 5	647185.00	9909365.00	86	1,42	
POINT 3	647519.00	9909554.00	152	2,96	CURRENTLY
POINT 8	647933.00	9909702.00	346	5,02	LOW
POINT 6	648118.00	9909296.00	338	5,2	
POINT 2	647715.00	9909143.00	270	5,27	
POINT 9	647365.00	9908970.00	346	8,36	
POINT 1	646993.00	9908796.00	214	8,43	
POINT 10	646553.00	9908570.00	322	9,86	

Based Table 1 above is the result of the dominant frequency analysis. The results of the research obtained three categories of vulnerability in the region, namely: high, medium, and low. Based on the analysis results, the dominant frequency ranges from 0.641 Hz to 9.86 Hz. The results of the distribution of the dominant frequency values can be obtained in the form of contours using the Surfer 13 software in Figure 5:

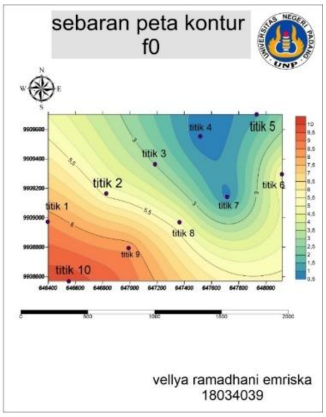


Fig 5. Dominant frequency distribution contour (f0)

Based on Figure 5 above is a contour map of the distribution of dominant frequency values. Based on this analysis, it can be concluded that areas with low dominant frequency values are indicated as areas prone to seismic hazards.

The amplification factor is the magnification of seismic waves due to very significant differences between layers. In other words, seismic waves will experience magnification if they propagate from one medium to another, which is softer. Based on the analysis of the H/V curve with the HVSR method using the geopsy software, the value of the wave amplification factor in the study area can be seen. For the amplification value of the medium category with the classification of the amplification factor by Setiawan [3]found at the measuring point 10, point 8, point 3, point 2, and point 9 with the amplification value found in the range 3-9. Meanwhile, for the high category amplification value, according to the classification of the amplification factor by Setiawan [3]it is found at point

7, point 1, and point 4 with the amplification value in the range 6-9. while the amplification value for the very high category with the classification of the amplification factor by Setiawan ([3]is at point 6, and point 5 with the amplification value is at 9. The following are the results of the data analysis of the amplification factor value at each measurement of the table 2:

Table 2. The results of the analysis of the amplification value factor data (A0)

Point Name	longitude X(m)	latitude Y(m)	elevation angle z(m)	Amplification factor A0	Vulnerability Category
POINT 10	646399.00	9908975.00	322	3,39	CURRENTLY
POINT 8	646829.00	9909165.00	346	3,77	
POINT 3	647185.00	9909365.00	152	3,91	
POINT 2	647519.00	9909554.00	270	3,96	
POINT 9	647933.00	9909702.00	346	4,97	
POINT 7	648118.00	9909296.00	256	6,33	TALL
POINT 1	647715.00	9909143.00	214	6,51	
POINT 4	647365.00	9908970.00	113	6,89	
POINT 6	646993.00	9908796.00	338	10,04	VERY HIGH
POINT 5	646553.00	9908570.00	86	21	

Based on the table 2 value of the amplification factor analysis above, it can be obtained that, in general, the distribution of the wave amplification factor values in the research area is in the range of 3.39 to 21. The distribution of the amplification factor values in the research area was obtained using Surfer 13 software look at Figure 6.

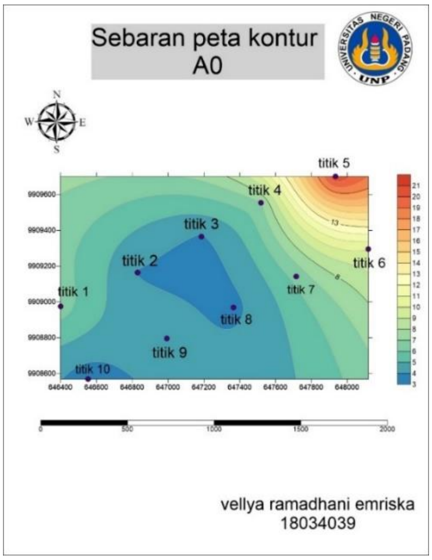


Fig 6. distribution contours of soil amplification factor values

Figure 6 above is a contour map of the distribution of amplification values. Based on this analysis, it can be concluded that the research area has a moderate category of wave amplification factors. This illustrates that if an earthquake occurs in the area, it is classified as safe because the magnification of the seismic waves in the region tends not to be significant. In areas that have high and very high amplification factors, it can be caused by several factors, namely the presence of a weathered layer that is too thick above the hard layer somewhere, an area has a low dominant frequency, the frequency of earthquakes and local geology is the same or close to the same, and energy earthquakes are trapped in weathered layers for a long time.

The period value is the time required for the wave to propagate through the surface sediment layer or to experience one reflection from its reflecting plane to the surface. The value of this period is inversely proportional to the dominant frequency (equation), so if the frequency is high, the period is lower. For the principal period value, the low vulnerability category is found at point 5, point seven, and point 4 with a dominant period value of > 0.4 seconds, which if it is connected with the soil classification table based on the value of the microthermal period by Kanai and ometo-Nakajima (table 3) it is known that the period value obtained from the data processing this classified as soil type IV with a very soft soil layer character and alluvial rock soil classification formed from deltaic sediment, topsoil, mud with a thickness of 30 meters or more (surface sediment thickness is very high). This thick). for the dominant period, the medium category is at point 3 measurement with the principal period value of 0.25-0.4 second, where if it this connected to the soil classification table based on the value of the microtremor period by Kanai and ometo-Nakajima (table 3), it this known that the period value obtained from the results of data processing classified as soil type III with soft layer characteristics and alluvial rock classification with a thickness of >5 meters consisting of sandy-gravel, and hard clay, loam (the thickness of the surface sediment is 10-30 meters thick). For the value of the dominant period in the high category, there are measurements of point 10, point 1, point 9, point 2, point 6, and point 8, with the dominant period being in the range of 0.10-0.25 seconds, which this connected with the soil classification table based on The value of the microtremor period by Kanai and Ometo-Nakajima (table 3) shows that the period value obtained from the data processing this classified as soil type II with a soft layer character. The soil classification is an alluvial rock with a thickness of 5 meters consisting of sandy gravel and stiff. Clay, loam. The following are the results of the analysis of the dominant period value data at each measurement point at table 3:

Table 3 Results of the analysis of the dominant period T0

Point Name	**longitude X(m)**	**latitude Y(m)**	**elevation angle z(m)**	**Dominant period T0**	**Vulnerability Category**
POINT 10	646399.00	9908975.00	322	0,1014	TALL
POINT 1	646829.00	9909165.00	214	0,1186	
POINT 9	647185.00	9909365.00	346	0,1196	
POINT 2	647519.00	9909554.00	270	0,1897	
POINT 6	647933.00	9909702.00	338	0,1923	
POINT 8	648118.00	9909296.00	346	0,1992	
POINT 3	647715.00	9909143.00	152	0,3378	CURRENTLY
POINT 5	647365.00	9908970.00	86	0,7042	LOW
POINT 7	646993.00	9908796.00	256	1,333	
POINT 4	646553.00	9908570.00	113	1,628	

Based on the table 3 analysis of the dominant period above, it can be obtained that the distribution of the values of the dominant period is in the range of 0.1014-1.628 seconds. The following is a contour map of the distribution of the overall period values obtained using Surfer 13 software an the figure 7:

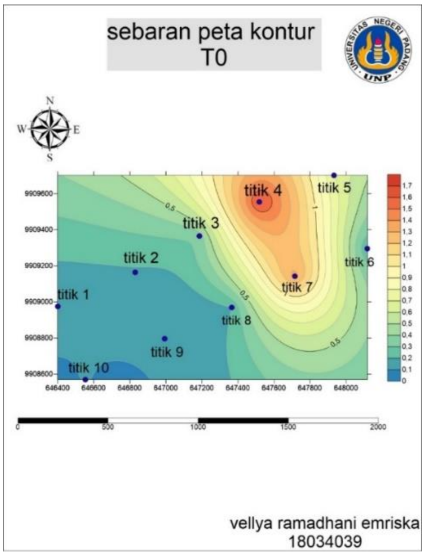


Fig 7. T0 dominant period distribution contour

From Figure 7 above, it is a distribution contour map with a dominant period. The area with a high dominant period is indicated as an area with a high seismic hazard, and it can be seen in table 3 with the character of the soft soil layer.

This seismic vulnerability index is obtained by comparing the value of the amplification factor with the dominant frequency (equation 6). based on the calculation of the seismic susceptibility index value in the research area, the value of the low category seismic vulnerability index according to the classification of the seismic susceptibility index value by Refrizon [11]is found at the measurement of point 10, point 8, point 9, and point 2 with a seismic vulnerability index of at vulnerable <3. for the value of the seismic susceptibility index in the medium category according to the classification of the seismic vulnerability index value by Refrizon [11]it is found at the measurement point 1 and point 3 with the seismic vulnerability index at vulnerable 3-6. while the seismic vulnerability index value in the high category according to the classification of the seismic vulnerability index value by Refrizon [11] is found at point 6, point 7, point 4, and point 5, with a seismic vulnerability index found at >6. Based on this value, it can be seen that the higher the vulnerability index of an area, the more the room will feel the earthquake's impact. Or in other words, the site also has a high earthquake intensity scale. Following are the results of data analysis of seismic vulnerability index values at each measurement point the table 4:

Table 4 Results of data analysis of seismic susceptibility index values (Kg)

Point Name	**longitude X(m)**	**latitude Y(m)**	**elevation angle z(m)**	**seismic susceptibility index**	**Vulnerability Category**
POINT 10	646399.00	9908975.00	322	1,655	LOW
POINT 8	646829.00	9909165.00	346	2,831	
POINT 9	647185.00	9909365.00	346	2,954	
POINT 2	647519.00	9909554.00	270	2,975	
POINT 1	647933.00	9909702.00	214	5,0272	CURRENTLY
POINT 3	648118.00	9909296.00	152	5,1648	
POINT 6	647715.00	9909143.00	338	19,384	TALL
POINT 7	647365.00	9908970.00	256	53,4252	
POINT 4	646993.00	9908796.00	113	77,3161	
POINT 5	646553.00	9908570.00	86	310,563	

Based Table 1 above is the result of the dominant frequency analysis. Where from the results of the research, 3 categories of vulnerability in the region are obtained, namely: high, medium, and low.Based on the results of the seismic vulnerability index analysis above, it can be obtained that, in general, the distribution of the seismic vulnerability index values in the measurement area is in the range of 1,1655-310,563, with the distribution of values obtained in Surfer 13 software as follows the figure 8:

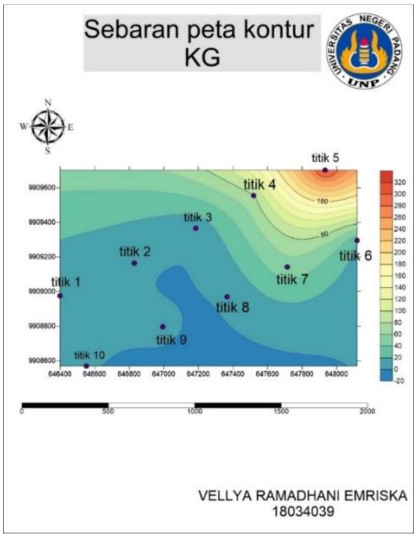


Fig 8. The contour of the distribution of seismic susceptibility index values (Kg).

Based Figure 8 above is a contour map of seismic vulnerability index values distribution. The value of the seismic vulnerability index is closely related to the level of vulnerability of an area (soil) to deformation. The higher the seismic vulnerability index, the weaker the site (can change) in the event of an earthquake. Based on the microzonation of the distribution of dominant frequency values in the measurement area, low-frequency values are generally distributed in regions with date formation type geological formations, which explains that the site is marl rock interspersed with calcareous siltstone and calcareous sandstone with an outcrop thickness of 500-1000 meters. This low-frequency area this indicated as an area with a high seismic hazard. It can be seen in table 1 with the character of the soil layer being very soft. Some areas are in conditions that are vulnerable to seismic hazards, namely at the measurement points: point 8, point 6, point 2, point 9, point 1, and point 10. The following is a view of the microzonation map in Figure 9.

Fig 9. Microzonation map of the distribution of dominant frequency values in Koto Tangah sub-district, Padang city

Figure 9 is an image of the dominant frequency distribution microzonation map in the Koto Tangah area, where it can be seen on the map that areas with high seismic hazards are areas with a yellow color range. The amplification factor in the area is related to the resonance of the seismic waves in the area. The amplification factors in a room are directly proportional to the dominant period in an area (equation 6). The amplification factor describes the magnitude of the wave amplification when it passes through a particular medium. A high dominant period in an area shows the tendency of a place to experience a high amplification factor so that it is vulnerable to damage during an earthquake (Darsiman, 2016). Based on the distribution of the amplification factor values in the research area, it can be seen based on the classification of the amplification values by Setiawan (table 2) for the distribution of the amplification factor being found at the measurement points of point 10, point 8, point 3, point 2, and point 9. high amplification is located at point 7, point 1 and point 4. And for the distribution of very high amplification factors is at points 6 and 5. The following is a view of the microzonation map in Figure 10.

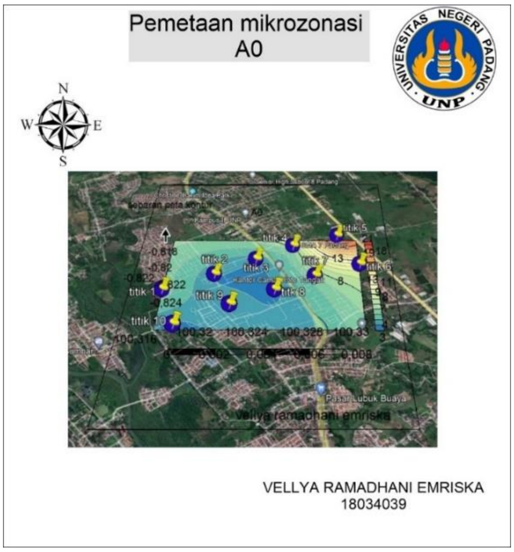


Fig 10. Microzonation map of the distribution of amplification factor values in Koto Tangah sub-district, Padang city

Figure 10 is an image of the dominant frequency distribution microzonation map in the Koto Tangah area, where it can be seen on the map that areas with high seismic hazards are areas with a yellow color range. The dominant period is the opposite of the dominant frequency. By equation 5, it can be concluded that there is an inverse relationship between the value of the dominant frequency and the dominant period, namely, if the frequency is low, the period is higher, and vice versa, if the frequency is high, the period will be intense. Based on the microzonation of the distribution of the dominant period in the measurement area, for the high dominant period value, it is generally distributed in regions with date formation type geological formations, which explains that the site is marl rock interspersed with calcareous siltstone and calcareous sandstone with an outcrop thickness of 500-1000 meters. The area with a high dominant period is indicated as a high seismic hazard, as seen in table 3 with its soft soil layer character. Some areas are in conditions that are vulnerable to seismic hazards, namely at the measurement points: point 8, point 6, point 2, point 9, point 1, and point 10.

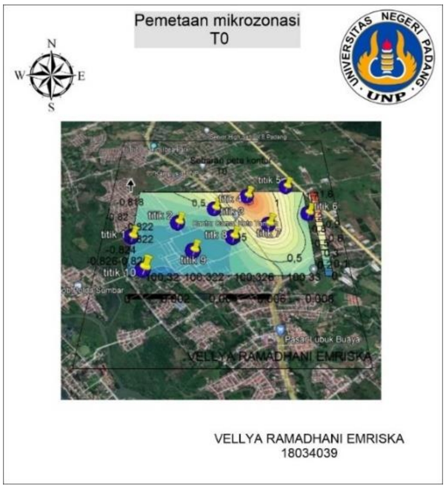


Fig 11. Microzonation map of the distribution of dominant period values in the Koto Tangah sub-district, Padang city

Figure 11 is an image of the dominant frequency distribution microzonation map in the Koto Tangah area, where it can be seen on the map that areas with high seismic hazards are areas with a yellow, blue,and green color range. Seismic vulnerability describes the level of exposure of the surface layer to deformation during an earthquake. The value of the seismic susceptibility index at each observation point can vary even in the same geology. This vulnerability index helps detect areas that are unconsolidated sediments during an earthquake. Based on the microzonation of the distribution of seismic susceptibility index values in the study area, it is known that the seismic vulnerability value is by the classification of the seismic vulnerability index value by Refrizon [11]in the low category spread over the measurement points of point 10, point 8, point 9, and point 2. the value of the vulnerability index in the medium category according to the classification of the seismic vulnerability index value by Refrizon [11]is found at point 1 and point 3. Meanwhile, the value of the high category seismic vulnerability index, according to the classification of the seismic vulnerability index value by Refrizon [11]is at point 6, point 7, point 4, and point 5. The following are the results of the microzonation of the distribution of the seismic susceptibility index values that are overlaid in the local area figure 12:

Fig 12. Microzonation map of the distribution of seismic vulnerability index values in the Koto Tangah sub-district, Padang city

Figure 12 is an image of the dominant frequency distribution microzonation map in the Koto Tangah area, where it can be seen on the map that areas with high seismic hazards are areas with a yellow and blue color range. Based on the microzonation of the distribution of dominant frequency values, amplification factors, dominant periods, and seismic susceptibility index values in the research area, it can conclude that, in general, this area has a relatively high seismic hazard level. This can see in the measurement area, dominated by dominant frequency values, amplification factor, dominant period, and seismic vulnerability index, which are included in the high to medium category. In addition, the factors that influence the high level of seismic hazard in this area can also be seen in the geological conditions around the research area, which explains that alluvial soil layers dominate this research area, and this is dominated by limestone as bedrock[12]

IV. CONCLUSION

Based on the results of the study, it can be concluded as follows: The influence of local effects on seismic hazards in the research area, which includes geological conditions and soil conditions, can be seen from the dominant frequency value F0, the dominant period T0, soil amplification A0, and seismic susceptibility index Kg, where from the data analysis it can be concluded that the area is vulnerable to seismic hazard with a high to moderate category. Where is this based on the microzonation of regions prone to seismic hazards in the measurement area? It can be seen that the measurement area is dominated by areas prone to seismic hazards whose data this seen from the distribution of microzonation values of dominant frequency (f0), amplification factor (A0), dominant period (T0), and the value of the seismic vulnerability index (Kg) which is included in the medium to high category due to the influence of underground geology.

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