ANALYSIS OF SHEAR WAVE VELOCITY (Vs) USING MULTICHANNEL ANALYSIS OF SURFACE WAVES (MASW) IN JAMBI LUAR KOTA SUB-DISTRICTS

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ABSTRACT

Jambi Luar Kota is one of the sub-districts with an increasing population density and development level. It can be seen in the last 10 years (2010-2020), 39 populations/km^2 with a total population of 62,687 people. The increase in population density impacts infrastructure development, which also increases. The site class maps need to be considered for infrastructure development by considering the development rules in accordance with SNI 1726:2019. This study used the Multichannel Analysis of Surface Wave (MASW) method, which measures variations in surface wave velocity with 21 lines. The average value of the shear wave velocity at a depth of 30 m MASW measurements ranged from 153.24 m/s - 420.86 m/s, consisting of SC site class, SD site class, and SE site class. SC site class with a Vs30 value of 358.88 m/s-420.86 m/s was found on the east side of the middle part of the Jambi Luar Kota Sub-district. Meanwhile, the SD site classes are evenly distributed in the Jambi luar Kota Sub-district. The SE site class is located on the north and east sides of the Jambi Luar Kota Sub-district with a Vs30 value of 153.24 m/s, which in this case is supported by geotechnical data in the form of water content (w) (43.03%), plasticity index (PI) (23.26) and a shear strength test of 17,652 kPa. The area with a low Vs30 value (<175 m/s) is an area that has the potential to get relatively more significant shocks when ground movement occurs.

Keywords: Site class, Vs30, Jambi Luar Kota Sub-district, MASW

1. Introduction

Jambi Luar Kota Sub-district is one of the sub-districts with an increasing level of community density and development; as a sub-district in which the Jambi University and State Islamic University campuses state, the construction of multi-story buildings and housing are intensively carried out in line with regional autonomy. This development can be seen from the many construction projects, such as shophouses, housing, health facilities, and infrastructure.

The development of population growth in the Jambi Luar Kota Sub-district during the last 10 years (2010-2020) has increased by 39 people per km2, namely from 210 people per km2 to 249 people per km2 with an area of 280.12 km2 and a total population of 62,687 people [1]. The large population and increasing development have resulted in the possibility of soil instability, which is inseparable from the condition of the rock layer and morphological shape in some areas of the Jambi Luar Kota Sub-district. It is also caused by human activities that change the landscape, causing regional instability, such as mining, agriculture, housing, and road construction [2].

Jambi Province is prone to tectonic earthquakes caused by the Sumatra Fault, known as the Semangko Fault [3]. This fault became the history of seismicity in Kerinci Regency and Sungai Penuh City in 1908 and 1995 [4, 5]. In 1926, Kerinci Regency witnessed two earthquake shocks from the Padang Panjang area [6]. It is also possible that earthquake tremors will reach the Jambi Luar Kota Sub-district, resulting in ground movement that can trigger building damage if an earthquake occurs in other areas that the people of Jambi Luar Kota Sub-district can feel.

Based on geological information, the area is located in the Muaraenim Formation (Tmpm), Kasai Formation (Qtk), Air Benakat Formation (Tma), and alluvium area (Qa), which on average, is dominated by fine sediments [7]. These conditions have a more significant potential hazard to the effects of ground vibration intensity due to the amplification and interaction of ground vibrations on buildings due to earthquakes [8]. In addition, seismic wave propagation will be more robust when propagating in the fine sediment medium because there is space between grains, which results in seismic wave amplification [9]. This aligns with Solikhin and Suantika's research [10], which states that soft soil layers can cause more excellent earthquake vibrations than more complex soil layers when passed by earthquake waves. Hence, these results show that areas composed of soft lithology tend to experience seismic wave amplification.

Geological conditions also allow for soil instability, the influence of population density and infrastructure, and the overexploitation of groundwater due to population density. These conditions will be related to the impact of shocks that appear at the research location. The intended shocks are vibrations originating from human activities and transportation. Efforts to avoid the effect of soil instability can be made through good planning and construction processes. One way is to build buildings and infrastructure that pay attention to soil conditions by SNI 17026: 2012 [11].

Geophysical methods such as non-invasive seismic exploration are promising solutions for subsurface exploration, as they are relatively cheap, fast, and can be implemented in residential areas without difficulty [12]. In addition, there has been no related exploration at the study site. In seismology, there are two wave velocity parameters: Vp (compressive wave velocity) and Vs (shear wave velocity). The Vp wave velocity with refraction seismic tests is standard, while Vs with surface wave tests is rarely used for surface geotechnics [13]. Geophysical methods that can obtain shear wave velocity (Vs) are the microtremor method [14] and the Multichannel Analysis of Surface Waves (MASW) method. This research uses the MASW method because its resolution is better than the microtremor method, which can produce shear waves (Vs) [15]. Analysis of MASW can also be done as important information in the geotechnical field to design buildings that are resistant to shocks and do not cause cracks in the foundation and walls of the house [16].

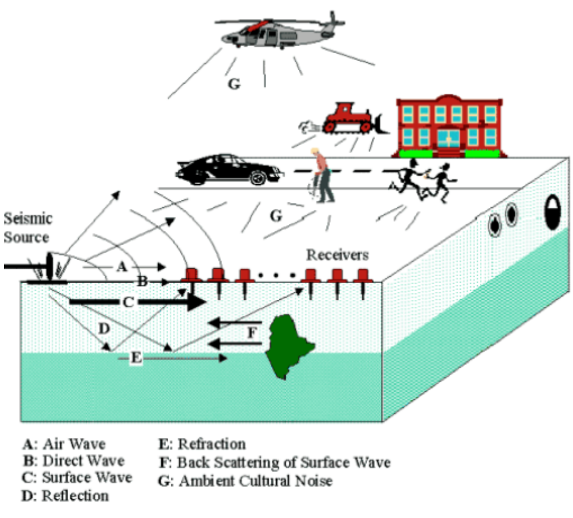

Figure 1. Survey overview of MASW method [17]

Based on the problems previously described, this research aims to map the shear wave velocity (Vs) value, classify the soil class (site class) based on SNI 1726: 2019, and find out the geotechnical parameters as a supporter of soil class validation in Jambi Luar Kota Sub-district. The results of this study are expected to be considered by relevant parties in making soil class validation decisions and spatial planning decisions by SNI 1726: 2019. This research is vital because there has yet to be related geophysical research in the Jambi Luar Kota Sub-district to anticipate unwanted events.

Multichannel Analysis of Surface Waves (MASW). MASW methods based on the wave source used are divided into two types: active MASW methods and passive MASW methods. In the active MASW method, the wave source used must have a high frequency, for example, using a hammer or weight drop, while in the passive MASW method, the source used is a low frequency, for example, tides, vehicle traffic, and crowds of pedestrians, as shown in Figure 1.

However, this study uses the passive MASW-type method because it can describe the shear wave velocity structure to a depth of more than 100 m. Passive surface wave techniques measure noise, including surface waves originating from ocean wave activity, traffic, factories involving vibrating equipment, and wind and microtremors [18]. Passive MASW surveys are complementary to active MASW surveys [19], which often cannot reach sufficient depth, so their investigation and recording rely on natural waves or passive MASW surveys [20].

Shear Wave Velocity in the Depth 30 m (Vs30). The condition of the subsurface layer of an area can be known based on the physical properties of the materials that compose it. The shear wave velocity (Vs) parameter can describe these physical properties. The estimated value of Vs and the estimated distribution of earthquake damage can be used for earthquake mitigation and the determination of earthquake-resistant building standards. S-wave velocity is one of the constants closely related to Young's modulus because the most comprehensive and accurate definition of stiffness includes Young's modulus and shear modulus [22]. These two moduli can be defined as the density of the material and the two seismic velocities (Poisson ratio), Vp and Vs [23]. Therefore, the Vs information from the subsurface is directly related to the stiffness property of the material. Material stiffness is defined as a measure of resistance to deformation and is ultimately related to the elastic modulus of the material which is described as the behaviour of the material under stress.

Table 1. Classification of Soil Class Sites Based on Vs30 Values [21]

Site class	$\underline{Vs}$ (m/sec)	$\underline{N}$ or $\underline{N_{ch}}$	$\underline{S_u}$ (kPa)
SA (hard rock)	>1500	N/A	N/A
SB (rock)	750 to 1500	N/A	N/A
SC (hard soil, very dense soil and soft rock)	350 to 750	> 50	≥100
SD (medium soil)	175 to 350	15 to 50	50 to 100
SE (soft soil)	< 175	< 15	<50
	Or a soil profile containing more than 3 m of soil with the following characteristics: a. Plasticity index, PI > 20, b. Moisture content, w ≥40%, and c. Steady Shear Strength $\underline{S_u}$< 25 kPa		
SF (special soils, requiring specific geotechnical investigations and following site-specific response analysis)	Any soil layer profile that has one or more of the following characteristics: a. Prone to failure or collapse due to earthquake loading such as liquefiable soils, highly sensitive clays, weakly cemented soils b. Highly organic clay and/or peat (H > 3 m thickness) c. Very high plasticity clay (H > 7.5 m thickness with Plasticity Index PI > 75) d. Soft to firm clay layer with H > 35 m thickness with $\underline{S_u}$< 50 kPa		

Notes: N/A = not applicable

Shear wave velocity (Vs) is an important parameter to evaluate the dynamic condition of the soil. Shear waves are S waves, which means secondary or shear. They are called secondary waves because their velocity is lower than P (primary or pressure) waves. In a solid medium, shear waves transmit at velocities between 3-4 km/sec. When traveling in the subsurface, shear waves impart shear strain to the material they travel, hence the shear wave [24]. The Vs30 parameter is one of the parameters used to classify soil and rock types, as shown in Table 1. The classification of soil and rock types based on it is widely used for building and non-building planning, replacing conventional methods such as CPT (Cone Penetrating Test) and SPT (Standard Penetrating Test) [25].

One method that can be used to evaluate the dynamic condition of the soil is averaging the Vs values based on the propagation time from the surface to a depth of 30 m (Vs30) [26]. This value can be calculated using the following equation:

$$\mathrm{Vs30} = \frac{30}{\sum_{i=1}^{N} \left(\frac{h_i}{v_i}\right)} \quad (1)$$

Notation and thickness (meters) and shear wave velocity (when the shear strain level is 10-5 or less) of the formation or layer from a depth of less than 30 m [27]. A simple approach widely recognized as the standard for classifying soil types considering ground motion amplification effects is using the Vs30 parameter [28]. Measurement and mapping of Vs30 is a standard approach that can be used to determine the seismic condition of a site [29].

2. Methods

This research was conducted in the Jambi Luar Kota Sub-district using the passive MASW method and supporting data for validation of Vs30 in the form of geotechnical tests (SL07, SL13, and SL18), namely filter test, shear strength test, water content (w) test and plasticity index (PI) test using uPVC pipes from a depth of 0.8-1.2 m which are used to assist in classifying soil classes and knowing the type of rock found in the research area. MASW measurements used 24 geophones (3-meter spacing between geophones) on 21 lines (L01-L21) (Figure 2). Each geophone is connected using a take-out cable, which is then attached to the seismograph. The wave source used in the study came from a natural source on the surface. This distinguishes active and passive MASW data collection; active MASW uses vibration sources from hammers, weight, or dynamite (retrieval techniques are the same as refraction seismic), while passive MASW uses natural sources.

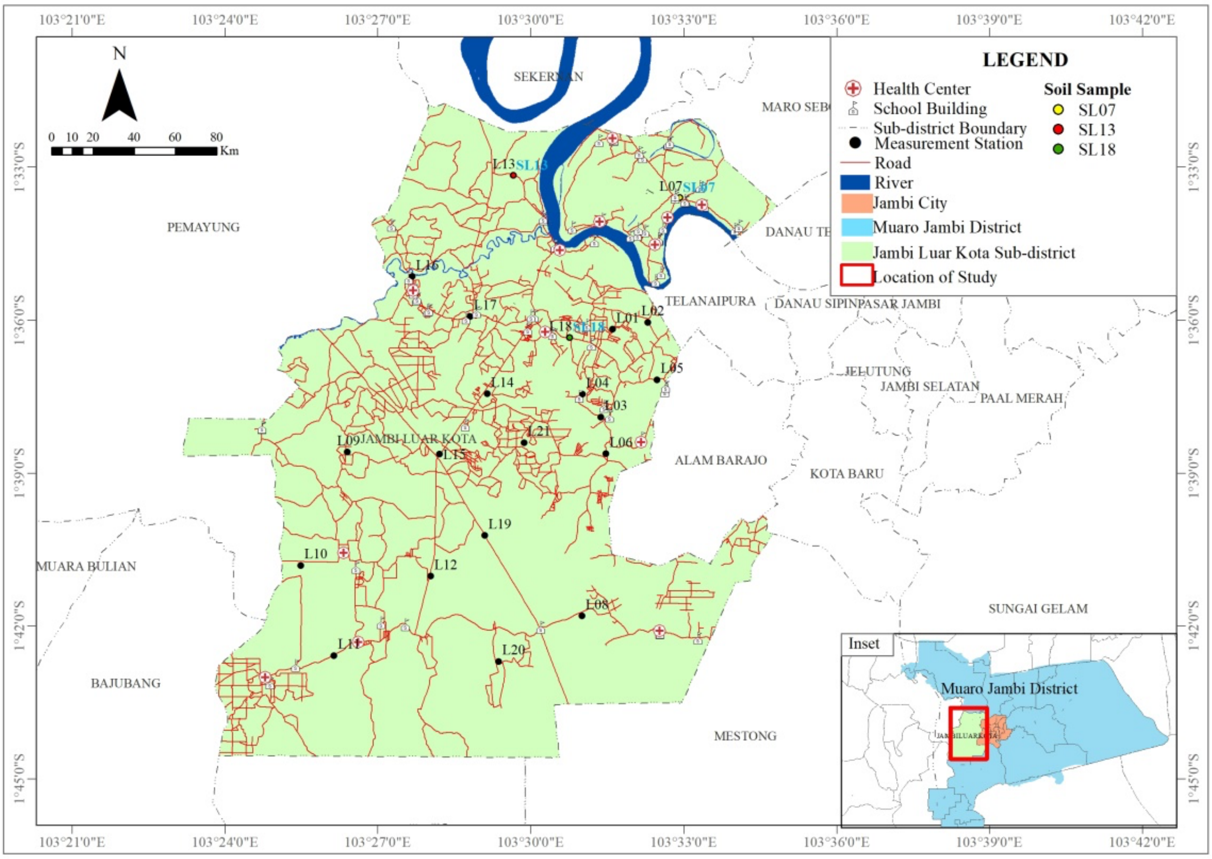

Figure 2. Measurement Lines and Sample Point of Soil Research in Jambi Luar Kota Sub-district

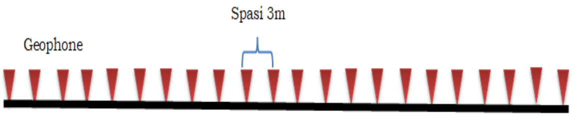

Figure 3. Sketch of Geophone Configuration during Measurement

The survey design of the equipment configuration is arranged in Figure 3 with the recording geometry in line spread, and the array type used is 1-D linear.

Seismic data obtained during acquisition with the multichannel analysis of surface wave (MASW) method is a shot gathered in the time and distance domain. Before that, it is necessary to edit the geometry to determine the location of the source to match the data acquisition in the field using front and express software. Further processing uses easy MASW software using phase velocity-frequency transformation to determine between the frequency and phase velocity limits to obtain the spectrum of the primary mode dispersion curve. In this process, the measurement data previously in the form of distance and time is converted into phase velocity and frequency, which, in this case, the transformation results in the form of a dispersion curve spectrum. After obtaining the dispersion curve, the next step is to adjust the wavelet's shape to make it easier to describe changes in phase speed against wave frequency during the picking process. After obtaining the phase velocity against the wave frequency, the next step is determining the initial model for the inversion process. Then, the 1D profile of the S wave against depth and the average value of the shear wave velocity at a depth of 30 m will be obtained. After that, the soil class classification is based on SNI 1726:2019, as in Table 1.

Soil sampling was conducted to obtain shear strength, w, and PI test parameters to classify soil classes based on SNI 1726:2019. After that, the sieve test was analyzed using the soil classification system from ASTM D 2487-66T. This sieve test supports the classification of soil classes obtained based on MASW data. After MASW and geotechnical test data were obtained, soil class analysis was conducted based on Vs30 values supported by geotechnical data as characteristics of SC, SD, and SE soil classes. Then, a Vs30 map and soil class map were made using *ArcGIS* 10.3, and a description of the results was carried out, which was compared with regional geology and analysis of the sieve test system to determine physical parameters and as supporting material for the soil class at the research location. Based on this explanation, the general research flow chart is shown in Figure 4.

Figure 4. Research Flowchart Results and Discussion

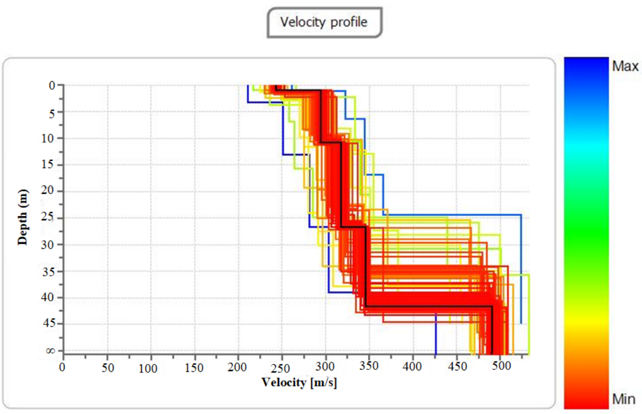

Figure 5. 1D Vs Profile of Inversion Results

The classification of soil classes is based on Table 1, in which geotechnical data is used as supporting data to validate the results of soil class classification. This geotechnical data is in the form of soil samples whose testing was carried out at the Construction Materials Laboratory of the Jambi Province Public Works and Public Housing Office. The selection of the sample data is based on the formation of the research area. MASW measurement data was then inversed to produce Vs. that can be used to determine soil class classification. Inversion was performed on all MASW measurement data, totaling 21 measurement stations. One example of the results of the inversion curve is shown in Figure 5, which is the result of the inversion of the measurement data of 06 lines (L06).

Figure 5 shows an example of the 1D Vs profile from the calculation of the inversion curve. The colors in the figure show the model curves resulting from the model iteration process with different misfit values. The black line shows data from field measurements, while the color range shows ground profiles with varying misfit values. The red color range (minimum) shows the model with the lowest misfit, and the blue color (maximum) shows the highest misfit, which will obtain ground profiles Vs value and depth of layering from the model. This means the figure shows the agreement between the model and the data. The 1D Vs. The profile generated at each measurement point also shows the different types of rocks in the subsurface according to the material that makes up the soil.

Pradita et al. have also researched MASW [30], which was conducted in Jakarta using 21 lines throughout Jakarta, which has an area of 661.5 km². The aim is to map Vs30 in the city of Jakarta. The results obtained are the distribution of Vs30 with a value range of 138 m/s to 358 m/s. Meanwhile, this research uses the same number of lines, namely 21 lines with an area of one-third (280.12 km²) of the Jakarta area. The distribution of points is based on regional geology, population density, location access, and time.

The Vs30 value can provide information on the character of the rocks that make up the subsurface. Theoretically, the shear wave propagation value is more significant in hard rock due to its compact structure and weaker in soft rock. Based on this response, the subsurface geological characteristics that make up an area can be known when conducting geotechnical planning. In Figure 6, Vs30 values with high values are marked with a blue color index located on the east and southeast sides of the Jambi Luar Kota Sub-district. Meanwhile, low Vs30 values are located north of the Jambi Luar Kota Sub-district. The difference in values obtained is due to the response derived from the propagation of seismic waves in a rock medium that indicates the physical properties of the subsurface rock layer. The higher the Vs30 value in the Jambi Luar Kota Sub-district, it can be interpreted that the Jambi Luar Kota Sub-district has a more compact and robust subsurface structure with low water content.

Solid and compact rocks tend to have complex structures with properties that can amplify seismic waves. This is also supported by Stokoe et al. [32], which state that the greater the Vs. Value: the more significant the soil stiffness value, the more complex and denser it is. The speed of wave propagation is also influenced by the characteristics of the soil layers, such as the rigidity and density of the medium layer (mineral composition, fractures, and rock pores), according to Indra et al. [33] which states that the Vs. The value measured in each place will have different variations in the Vs. Value due to the characteristics of Vs., which depend on the subsurface constituent material. This shows that the greater the Vs value in the subsurface, the more compact the constituent rock type.

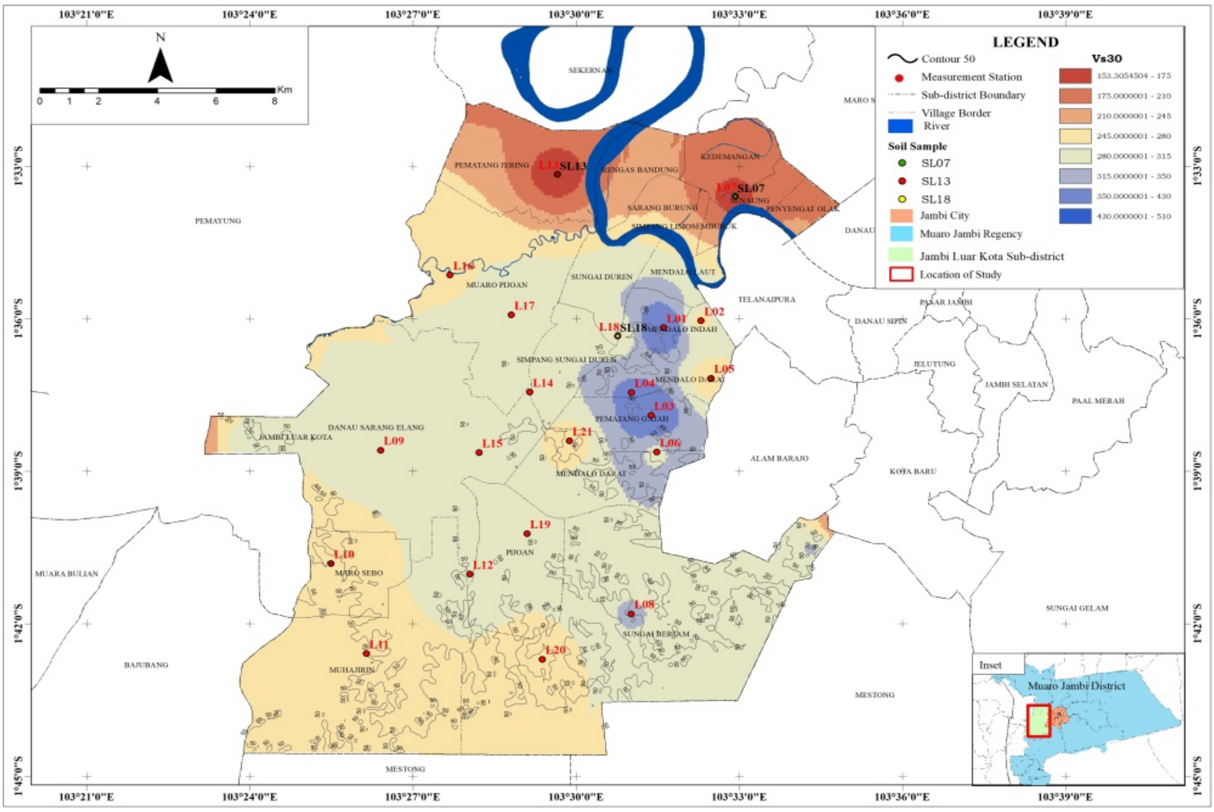

Figure 6. Distribution Map of Vs30 in Jambi Luar Kota Sub-district

Table 2. Measurement Results of Vs30 in Jambi Luar Kota Sub-district

No.	Trajectory	Vs30 (m/s)	Soil Class
1	L01	420.86	SC
2	L02	272.37	SD
3	L03	419.05	SC
4	L04	358.88	SC
5	L05	248.97	SD
6	L06	308.96	SD
7	L07	278.30	SD
8	L08	317.07	SD
9	L09	297.49	SD
10	L10	255.92	SD
11	L11	254.44	SD
12	L12	303.65	SD
13	L13	153.24	SE
14	L14	290.98	SD
15	L15	298.48	SD
16	L16	274.73	SD
17	L17	313.17	SD
18	L18	281.04	SD
19	L19	283.72	SD
20	L20	259.63	SD
21	L21	252.27	SD

Soft rocks tend to have properties that can weaken seismic waves so that they have a high propagation period. The smoother the rock, the smaller the Vs velocity value will be because the Vs value is directly proportional to the rock density [25]. When planning a significant development, one must pay more attention to the subsurface conditions because a small Vs30 value and high water content will affect the stability of the soil below the surface. The condition of soft soil itself will experience greater movement amplification compared to more consolidated soil [34]. This is also stated again by Anbazhagan (2011) [35], who states that shocks tend to be stronger in locations with softer surface layers.

3. Result and Discussion

Based on Figure 7, Jambi Luar Kota Sub-district is composed of SC soil class, SD soil class and SE soil class. The SC soil class, which is composed of hard, very dense soil and soft rock, is marked with a red color index located on the eastern side of the sub-district. The SD soil class is a medium soil type with a light green color index that is evenly distributed in the Outer City Jambi District. Then the SE soil class is a soft soil type marked with a pink color index which is scattered in the northern part of the Jambi Luar Kota Sub-district. The Vs30 value (Table 2) of MASW measurements shows that the Vs30 value in the Jambi Luar Kota Sub-district ranges from 153.24 m/s - 420.86 m/s.

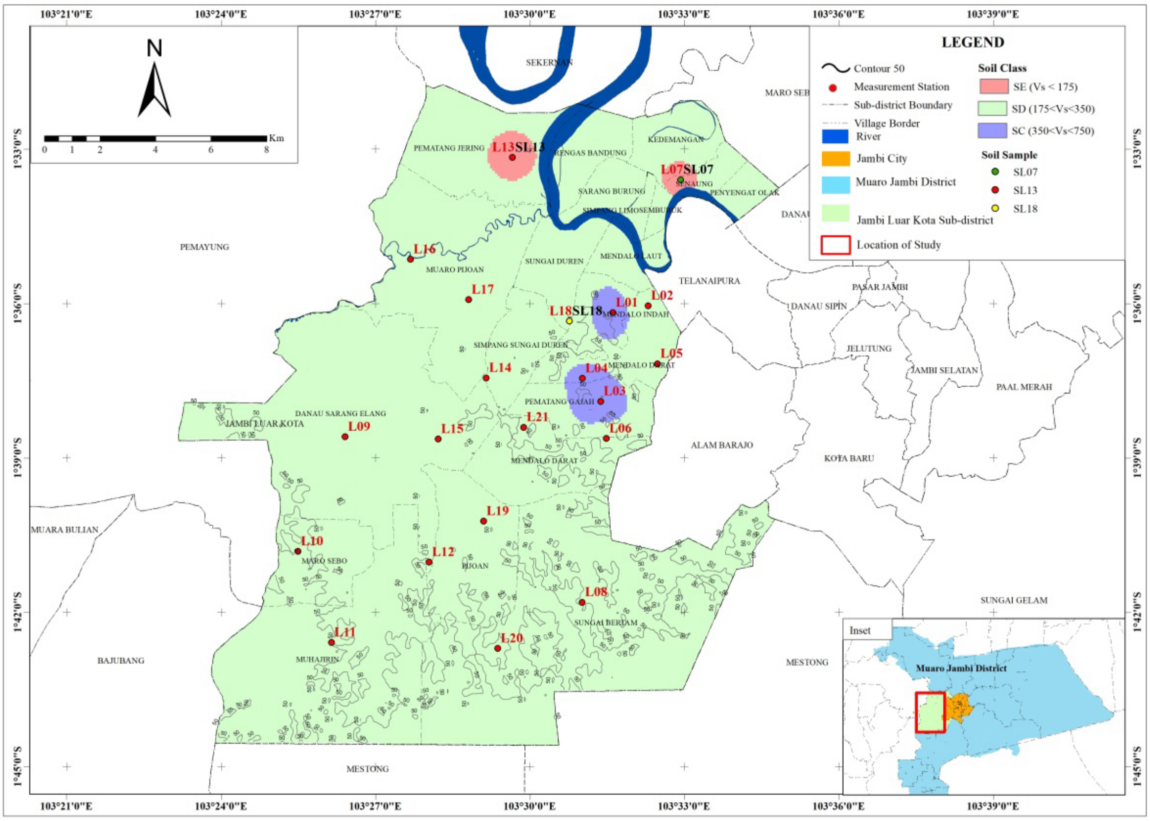

Figure 7. Soil Class in Jambi Luar Kota Sub-district

Table 3. Classification of Soil Classes Based on Vs30 and Geotechnical Analysis

No.	Sample	Formation	Vs30 (m/s)	Soil class	Geotechnical data		
					Moisture content (w)	Plasticity Index (PI)	Shear Strength (kPa)
1.	SL07	Qtk	278,30	SE	40,67%	23,15	14,709
2.	SL13	Qa	153,24	SE	43,03%	23,26	17,652
3.	SL18	Tmpm	281,04	SD	30,17%	11,64	16,671

The soil class classification based on formation and geotechnical analysis (Table 3) is dominated by medium and soft soil classes. Soft soil types are found at L13 and L07, while medium soils are found at L18.

Soil Class SC (Hard, very dense soils and soft rock), Vs30 of 350 to 750. The challenging soil class in the Jambi Luar Kota Sub-district is located on the east side of the center of the Jambi Luar Kota Sub-district, which represents the L01, L03, and L04 lines. Soft soil on the line is likely due to the subsurface rock layer that has undergone lithification or unification; this is also evident from data collection, where the soil on the line is hard as unified and different from other data collection locations. This hard soil is suitable for development because it usually has a significant bearing capacity. The bearing capacity of this soil can be calculated by first conducting sondir or boring tests.

Soil Class SD (Medium Soil), Vs30 of 175 to 350. Medium soil can be interpreted as unconsolidated sediment, meaning that the soil is composed of minerals that are not yet compact with each other so that they do not form rocks. Soil class D (L18) located in the Jambi Luar Kota Sub-district has a moisture content test (w) of 30.17%, a plasticity index (PI) value of 11.64, and a shear strength test with a cohesion value of 16.671 kPa and a sieve test which states the classification of soil types based on the ASTM D 2487-66T soil classification system states that line 18 is included in the classification of CL soil types (C = clay, L = low plastic with LL <50) which means it is included in the classification of inorganic clay with LL <50.50) which means that it is included in the classification of inorganic clay with low or medium plasticity, clay and gravel, sandy clay, silty clay, clay with low viscosity. Based on this, the medium soil layer in this line is dominated by mudstones with low viscosity, which means that the resistance to change is very low. Based on this analysis, then between SL18, regional geology shows compatibility because both show the presence of medium soil class.

Soil Class SE (Soft Soil), Vs30 of <175. The E (L13) soil class located in Pematang Jering Village of Jambi Luar Kota Sub-district is supported by the Vs30 value, which is by SNI 1726:2019 (Vs. <175) of 153.24 m/s is also supported by a high moisture content (w) test of 43.03% (>40%), a plasticity index (PI) value of 23.26 (>20%) and a shear strength test with a cohesion value of 17.652 kPa (<25 kPa) as well as a sieve test that states the classification of the soil type based on the classification of the soil based on the classification of the soil.25 kPa) and the sieve test, which states the classification of soil types based on the ASTM D 2487-66T soil classification system, states that line 13 is included in the ML soil type classification (inorganic silt, wonderful sand, fine silty sand or clay) so that in this case between the supporting samples and the results of direct field measurements in the form of Vs30 are the same. This means that the higher the water content, the higher the load above the surface could be because if given considerable pressure with high water content, it will cause the load above the surface to decrease or easily crack in the condition of buildings made of concrete. This is because the geotechnical parameters obtained on this line are included in the clay soil, which is also based on the data collection conditions near the Batanghari River.

In addition to L13, L07 (Senaung Village) based on geotechnical data is included in the classification of soft soil types with a moisture content (w) test value of 40.67% (>40%), plasticity index (PI) value of 23.15 (>20) and shear strength test with a cohesion value of 14.709 (<25 kPa). As well as the sieve test which states the classification of soil types based on the ASTM D 2487-66T soil classification system states that the classification of soil types in L07 is the CH soil classification (C = clay, H = highly plastic with LL> 50) which means that it is included in the type of inorganic clay classification with high plasticity, clay with high viscosity. Based on this, it can be said that this medium soil layer is dominated by mudstone which has a high viscosity, which means that the type of medium soil has a very high level of resistance to change. However, based on the Vs30 data value, the area is included in the medium soil type classification. The possibility of differences between Vs30 and geotechnical data is most likely due to tool burnout. This is because during data collection, the process of waiting for equipment takes a very long time with increasing community activities around data collection. The final classification until it is decided into the soft soil classification itself is based on geotechnical data which is included in soft soil and based on regional geological maps the area in the line is included in the Kasai Formation and with alluvium areas and data collection close to the Batanghari River.

From the Vs30 data, SE Soil Class in the Jambi Luar Kota Sub-district, this area is an area that has the potential to get relatively greater shocks when ground movement occurs due to vehicles on the surface than other areas in the Jambi Luar Kota Sub-district. Therefore, if development is carried out there will be cracks on the side of the building. Therefore, development in this area must pay attention to soil conditions and extra treatment such as the construction of deeper foundations and also soil compaction to avoid settlement due to consolidation. Loose soil should be compacted to increase its volume weight. The compaction serves to increase the strength of the soil, thereby increasing the bearing capacity of the foundation above it [35]. In line with research of Sairam, et.al., (2001) [36] which explains that building damage is generally greater in soft sediments than outcrops (bedrock) and stronger shocks occur in areas with low shear wave velocities or in thick sediments. Therefore, these areas require special attention in designing multi-storey developments.

This low shear wave velocity is in line with the geological review according to Mangga, et.al., (1993) [7] which states that the Jambi Luar Kota Sub-district consists of several formations which contain clay and silt rocks. One of them is alluvium deposits composed of crusts, sand, silt and clay which are scattered on the north side of the Jambi Luar Kota Sub-district and passed by the main river in Jambi province, namely the BatangHari river. Meanwhile, morphographically as described by Fadhlan and Intan (2020) [37], Jambi Luar Kota Sub-district is included in the lowlands, especially in the northern part of Jambi Luar Kota Sub-district which is dominated by alluvium. The results of the Vs30 spatial analysis also show conformity with these geomorphological and geological conditions.

The results that have been obtained from the calculation and analysis of the soil class, then in Table 4 it can be concluded that the Jambi Luar Kota Sub-district is divided into 3 soil class classifications, including the SC, SD and SE soil class classifications. The SC soil class is the recommended soil class for further development. The SD soil class still requires further calculation and analysis, which in this case according to Indra, et.al., (2018) [32] still needs to be done geotechnical engineering, where the engineering is carried out to harden the rock so that it can be used as the basis of the building by compacting the soil layer or by mixing it with limestone.

Table 4. Classification of Soil Class Sites in Jambi Luar Kota Sub-district

No.	Soil Class	Development Recommendations
1.	SC	Recommended
2.	SD	Advanced Calculations Needed
3.	SE	Not Recommended

SE soil class is not recommended for sustainable development. However, if you still want to do development, it can be done by doing further calculations for the building structure. As in the research of Wicaksana and Rosyidah (2021) [38] which compares the design response and behavior of SNI 1726: 2012 and 1726: 2019 building structures, one of which uses soil class data.

Based on Ali, et.al., (2018) [39] development on soft soil of clayey loamy peat type with soft consistency and high moisture content can be done by improving soil strength starting with dredging the top soil up to 1 m to remove the overburden and then engineering that can be done is by adding a rectangular foundation with a niche as an addition. Recommendations for construction can be made by knowing the soil class and bearing capacity of the soil. This is used to ensure the stability of the foundation which depends on the shear strength of the soil and its bearing capacity for ensuring that the foundation settlement does not exceed the allowable limit [40].

4. Conclusion

Jambi Luar Kota Sub-district has a Vs30 distribution with a value range of 153.24 m/s - 420.86 m/s and, based on SNI 1726: 2019, has three types of soil class classifications, namely Hard soil class (SC), (SD) soft soil (SE). Geotechnical test parameters in the Jambi Luar Kota Sub-district are the shear strength test, PI, w, and sieve test, which help classify and describe soil classes. The final classification until it is decided into the soft soil classification itself is based on geotechnical data that is included in the soft soil and based on the regional geological map the area in the line is included in the Kasai Formation and with the alluvium area and the data collection is close to the Batang Hari River. From the results of the soil class classification, it can be concluded that the SC soil class is the recommended soil class for further development. The SD soil class requires further calculation and analysis, and the SE soil class is not recommended for sustainable development. However, if you still want to do development, you can do further calculations for the building structure.

Suggestion

The perform advanced calculations to determine the type of foundation that is good for the soil that has been carried out, it is recommended thet more measurement lines can be analyzed on a regional scale to get better mapping results, and to get maximum results, you can use active methods to see the inversion results more clearly.

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