

IDENTIFICATION OF SUBSURFACE LAYERS USING THE SEISMIC REFRACTION METHOD IN THE TABIANG BARASOK AREA

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ABSTRACT

The Tabiang Barasok area stretches along the edge of the Sianok Canyon in Bukittinggi City. The natural conditions surrounding Tabiang Barasok, characterized by very steep slopes, are highly detrimental to the stability of the area. This was evident in the 2009 earthquake that caused landslides in the Tabiang Barasok area. Using the seismic refraction method, data processing was performed to obtain primary wave velocity and depth values for each subsurface trajectory. The processing results show that each trajectory consists of two layers, with velocities in the first layer being 218.05; 300.43; 222.75; and 314.35, interpreted as unsaturated sand for tracks 1 and 3, and weathered layers for tracks 2 and 4. In the second layer, the velocities were 447.64, 627.44, 327.12, and 541.87, respectively, interpreted as unsaturated weathered and gravel layers for tracks 1 and 3, and alluvium for tracks 2 and 4.

Keywords : Seismic Refraction, Subsurface layer, Tabiang Barasok



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I. INTRODUCTION

The need for information about subsurface structures is currently crucial for addressing needs such as minimizing the impact of natural disasters, building planning, and exploring groundwater sources. Subsurface structures are geological structures or conditions found in an area resulting from changes in rock due to tectonic or other processes. The soil layers in an area are influenced by geological and climatic conditions, resulting in differences in conditions. structure layer land in various region [1] . The Tabiang Barasok area is located in Bukittinggi City which is on the edge cliff canyon Sianok . Condition natural area this is what is there on Segmen Sianok own form very steep slope upright until hanging (overhanging) so very No profitable for stability region the [2] . Besides that , based on events around area Tabiang Barasok consequence earthquake in 2009, has happen movement the land that causes part of the cliff area Barasok covered by landslide material [3] . Information about the subsurface structure in the area Tabiang Barasok very important for know stability area Tabiang Barasok use minimize impact disaster nature. Area Tabiang Barasok will be developed into a new tourist destination currently under development, therefore subsurface layer detection is necessary to determine the condition of the subsurface layer in the Tabiang Barasok area. Determination of the subsurface layer structure uses a geophysical method, namely seismic refraction. Seismic refraction is part of seismological exploration classified as an active geophysical method, where measurements done use source vibration (hammer / blast) [4] . Method refraction used by emitting waves into the subsurface layer to obtain the soil and rock response recorded by geophones mounted above surface [5] . According to [6] with use method refraction , which is characterized by the propagation of refracted waves that experience a critical angle, where the waves have a higher speed when passing through the boundary between one layer and the layer below it. By using the seismic refraction method, the speed of seismic waves propagating below the ground surface can be determined. The observed parameters is characteristics time arrival geophone [7] .

The speed of the medium through which the wave travels can affect the length of time required. Wave seismic for pass layer. [8] . Speed wave seismic in rocks is influenced by factors such as rock type, density, porosity , depth , pressure , age rocks , and temperature [9] .The wave propagation velocity values obtained in the data processing calculations in this study are interpreted according to the type of material found below the surface based on the table. Speed propagation wave seismic (V_p) on Table 1.

Table 1. Speed Primary Waves On Some Mediums

Materials That Are Not Consolidated	V_p (m/s)	Material Consolidated	V_p (m/s)	other	V_p (m/s)
Weathered Layer	300-900	Granite	5000-6000	Water	1400-1600
Soil	250-600	Basalt	5400-6400	Air	331.5
Alluvium	500-2000	Metamorphic Rocks	3500-7000		
Clay	1100-2500	Sandstone and			
Sand Unsaturated	200-1000	Shale	2000-4500		
Sand Saturated	800-2200	Limestone			
Sand And Gravel Unsaturated	400-500		2000-6000		
Sand And Gravel saturated	500-1500				
Glacial Unsaturated	400-1000				
Glacial Saturated					
Glacial Compacted	1700				
	1200-2100				

(Source: Ref [10])

According to Sismanto , who was quoted in source [11] , in studies layer shallow , there are several basic assumptions required, as follows: The Earth is considered to consist of several layers, where the structure of each layer transmits seismic waves at different speeds. As depth increases, the rocks will become denser, the thickness of the earth's layers is greater compared to the wavelength, so that the propagation of seismic waves can be described as rays that follow the basic law of paths, and the wave speed will increase with depth. Based on [12] , several Factors that influence seismic wave speed include: density, lithology, depth, rock age, temperature, porosity, and pressure.

According to [13] , the method The cutoff time , delay time, and wave front methods are the primary methods for interpreting seismic data. There are also Hawkins's recursive method, the time-term inversion method, the plus-minus time method, the Hagiwara approach, the Matsuda method, and the Johnson distribution method, which was discovered several years later. One of the more recent methods discovered is a technique that finds solutions for subsurface layers where only the arrival time of the first wave is needed, and the time is calculated automatically . This known as method inversion time -term [14] . Using the time-term inversion method, the refractor is depicted as being located directly below the first geophone of the last shot, which is a combination of the forward direction of the last refractor under the first and last geophones, the location of the vibration source, both in the forward and backward directions be outside range geophone [15] .

II. METHOD

This study employed a quantitative methodology. Information was obtained through direct data collection in Tabiang Barasok, Bukit Apit Puhun District, Bukittinggi City (Fig 1). This study aimed to identify the subsurface composition based on seismic wave velocity (V_p) for disaster mitigation and to benefit Tabiang Barasok area managers in terms of development.

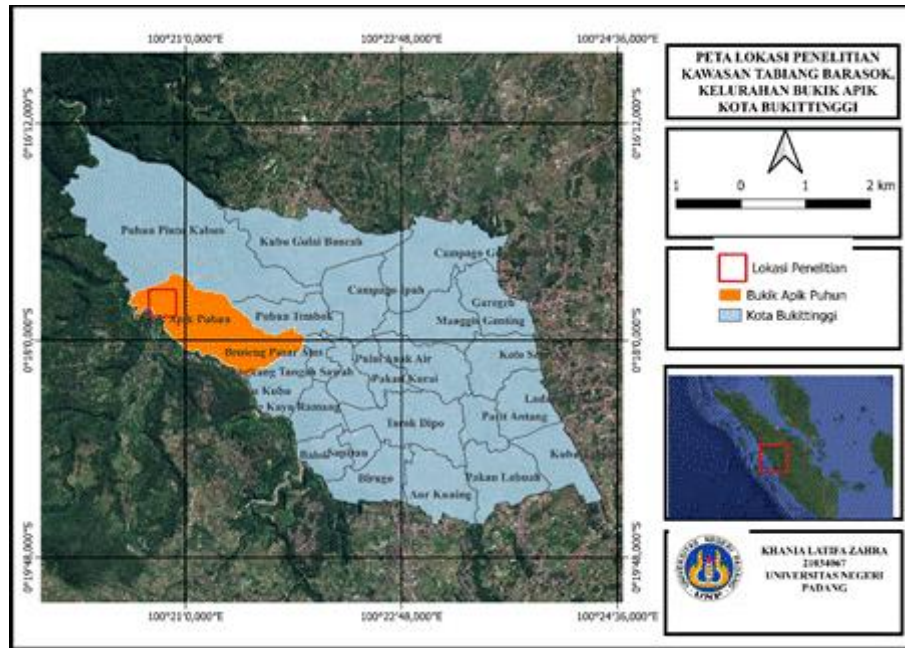


Fig. 1. Research Location Map

The vibration sources in the form of seismic hammers and iron plates, 12 geophones, trigger cables, Sysmatrack-Mae, geophone cables, and GPS for coordinates and elevation are the equipment used for seismic refraction data collection. Field measurements were carried out on 4 tracks using an in-line configuration. With a distance between geophones of 4 meters, so by using 12 geophones with vibration source points in the front and back directions, the total length of the track is 52 meters. The in-line configuration can be seen in Fig 2.

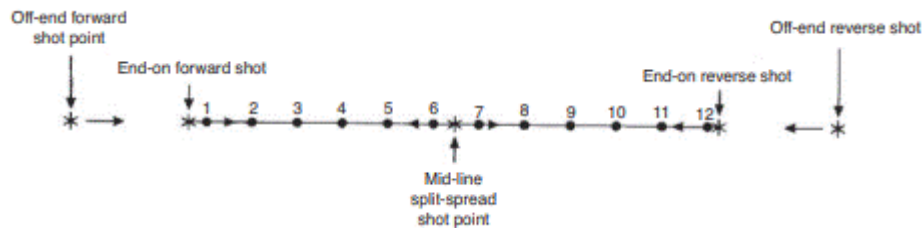


Fig. 2. Design Track Measurement Seismic Refraction [16]

The procedure for data collection or field data collection is as follows: First, determine the path to be used, second measure the length of the path up to 52 meters, third install the geophone cable while installing the geophone with a distance of 4 meters between each geophone, fourth insert the geophone into the ground, fifth use GPS, sixth connect the connecting cables, such as the geophone cable and trigger cable, to the Sysmatrack MAE system, then open the Sysmatrack application. Seventh, apply vibration using a hammer and iron at each shooting point three times in a row. Waves are automatically recorded on the seismograph, and the data is processed using Easy Refraction software. The obtained seismic data is then processed using Easy Refraction software for the sorting process, wave travel time, and seismic wave fiber velocity to model the subsurface layer cross-section.

Technique data processing is carried out after do data collection , as for step in technique data processing as following : inputting the results data measurement field on the easy refract software, then set number of geophones , first geophone positions spacing on part geophone position, after enter the geophone position data then press ok, then open the results data measurement on import trace section , then select the .sg2 format, then arrange existence source vibration on source position section , then when the wave amplitude No too visible can raised on trace section of each geophone , then do time picking arrive First wave with method enable show zoom on separate window for clarify appearance waves , then on the travel time curve tool do analysis with picking curve that has different slopes , then do data processing according to procedure previously for shot 2 and shot 3 with pressing knob add , after wave picking is done and picking the travel time curve for to three shot points later

do modeling with clicking tools calculate processed travel time curve, and in the interpretation tools obtained modeling lower surface like speed wave seismic as well as depth .

On data processing is used which Time-Term Inversion method method This is linear quadratic approach the smallest used For determine arrangement layer lower surface , on method this , marking layer only done For every first break in analyzing travel time data. On Refractor Time-Term inversion method depicted start from the first geophone on *shot point* First up to the first geophone on *shot point* lastly, which is combination between calculations *forward* from *shot point* first And *reverse* from *shot point* lastly. So that the picture refractor obtained in a way right below all over geophone arrangement , *shot point* First And final must place outside geophone array [15] .

III. RESULTS AND DISCUSSION

Based on the data collection carried out, initial data was obtained from 12 geophones with a path length of 52 meters each, with an interval of 4 meters for each geophone (Fig 3).

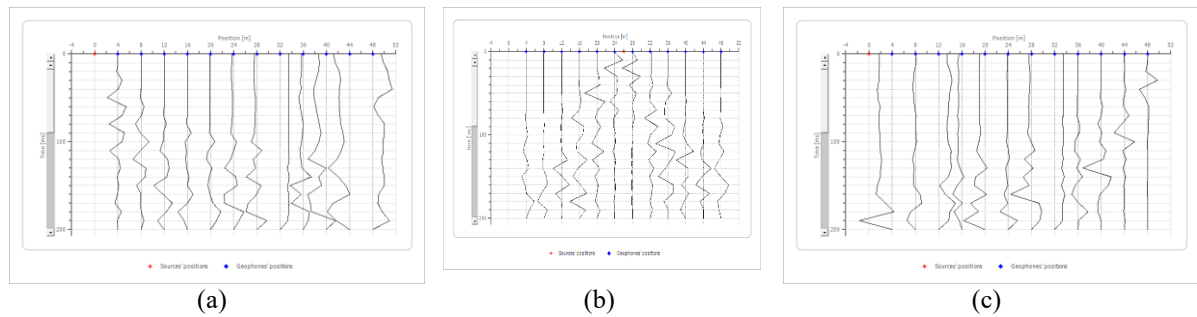


Fig. 3. Seismic waves recorded on each geophone on track 1.

As shown in Fig 3, which displays the seismic waves obtained from field data collection. Each trajectory has variations at three shooting points, and the first wave uses Easy Refraction software as shown in Fig 4.

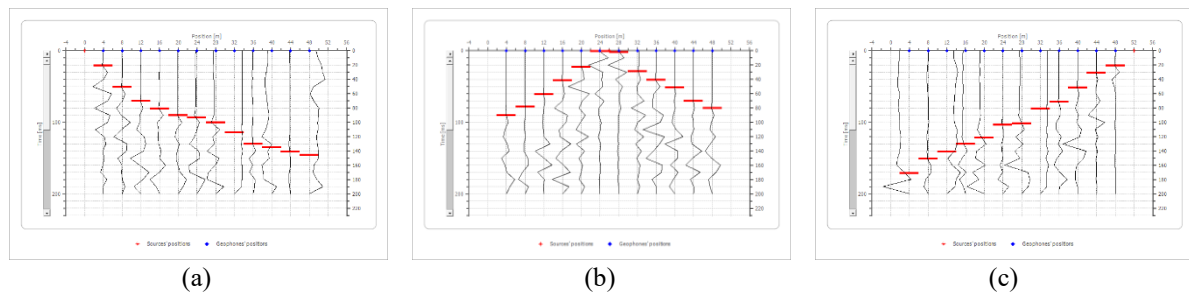


Fig. 4. Selection of seismic waves based on the first wave to arrive.

Fig 4 shows the results of determining the arrival of the first wave on route 1 with three variations of shooting points, which can be seen in Figure 4. The first shooting point is at a distance of 0 meters, the second shooting point at a distance of 26 meters, and the third shooting point at a distance of 52 meters. Using Easy Refraction software, the first wave is taken, then combined into one to form a travel time curve in the travel time curve section, which describes the relationship between time and distance as shown in Fig 5.

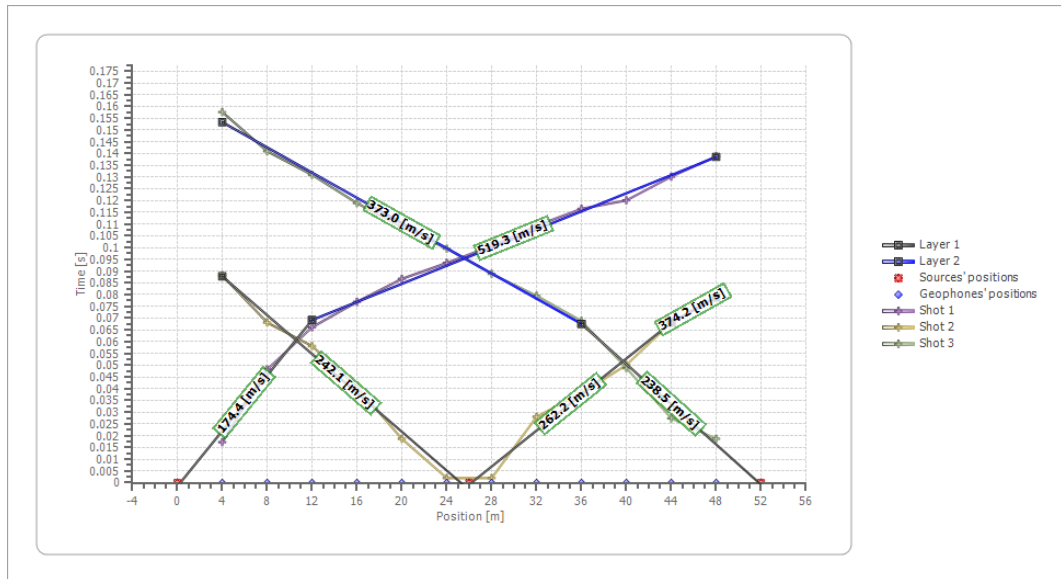


Fig. 5. Travel Time Curve for Trajectory

By using the time-term inversion method, the subsurface layer velocity value, the cross-sectional shape of the subsurface layer, and the wave velocity V_p value can be modeled. The wave velocity V_p value and the wave velocity V_p value and the depth of each layer can be seen in Fig 6, 7, 8, and 9.

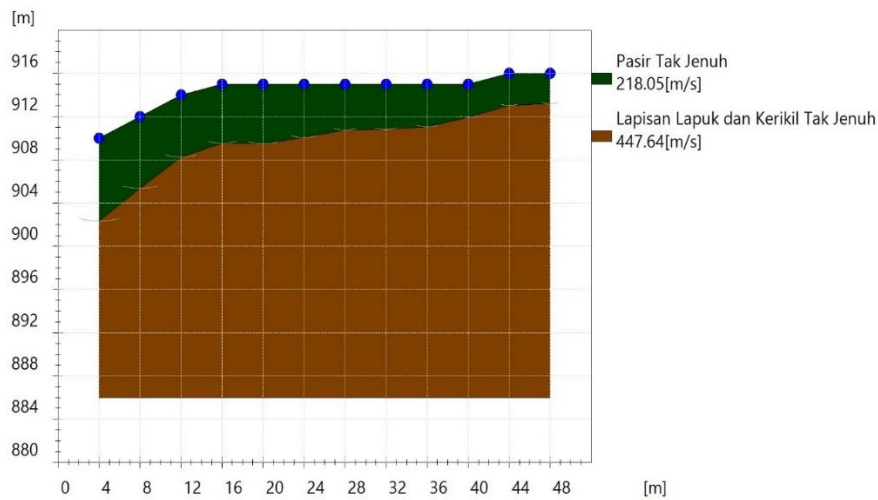


Fig. 6. Cross-sectional model of underground layers line 1

Fig 6 shows a cross-sectional model of the subsurface layer for trajectory 1, which is obtained in the form of two layers. The first layer is interpreted as unsaturated sand moving at a speed of 218.05 m/s, while the second layer is interpreted as eroded sand moving at a speed of 447.64 m/s.

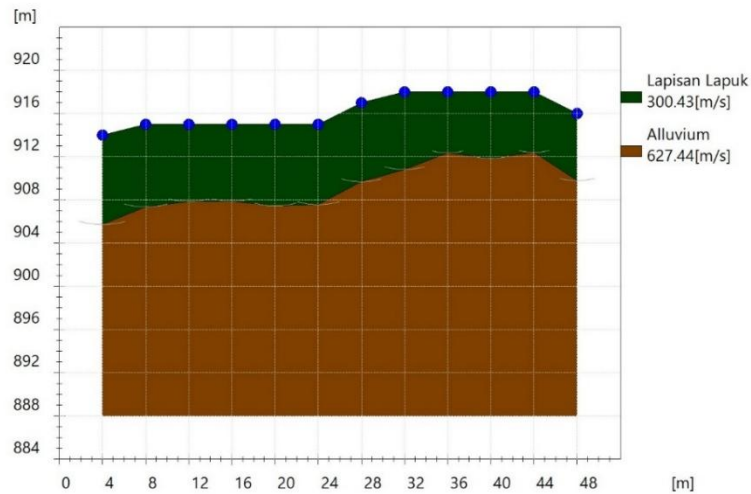


Fig. 7. Subsurface Layer Cross-Section Model Line 2

Fig 7 shows the cross-sectional model of the subsurface layer of Line 2, the results obtained in the form of two layers, where the first layer is interpreted as an eroded layer moving at a speed of 300.43 m/s, and the second layer is interpreted as alluvial deposits moving at a speed of 627.44 m/s.

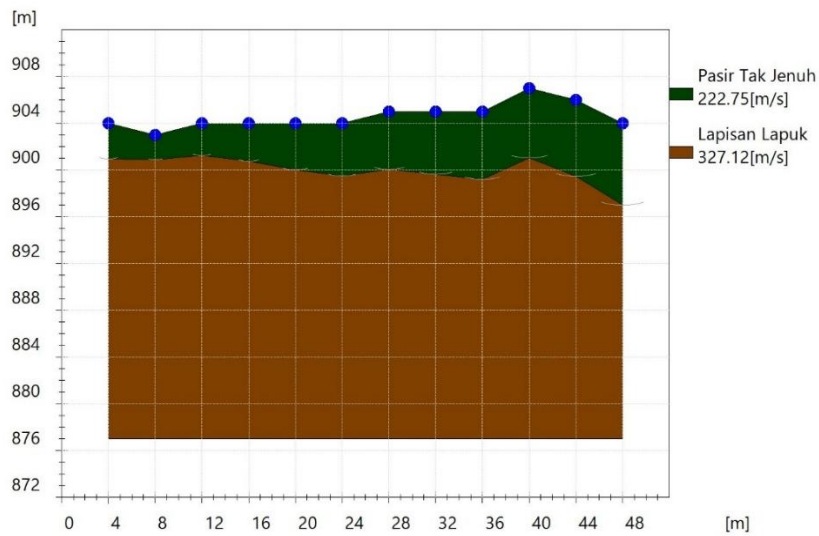


Fig. 8. Subsurface Layer Cross-Section Model Line 3

Fig 8 shows the cross-sectional model of the subsurface layer of track 3, the results obtained are in the form of two layers, where the first layer is interpreted as unsaturated sand moving at a speed of 222.75 m/s, and the second layer is interpreted as eroded sand moving at a speed of 327.12 m/s.

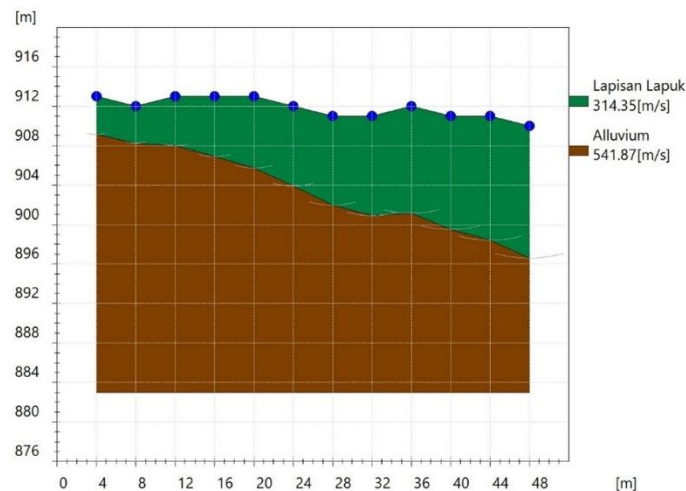


Fig. 9. Subsurface Layer Cross-Section Model Line 4

Fig 9 shows a cross-sectional model of the subsurface layer of track 4, the result is two layers, where respectively the eroded layer moves at a speed of 314.35 m/s, and the alluvium moves at a speed of 541.87 m/s.

Results Data processing shows that on each path there is a difference in the first arrival time of the P wave between the first and second layers. The difference in speed between the first and second layers shown by slope curve time traveled [17]. The results of data processing show that the layers below the surface have different subsurface velocities. For every layers, This is in accordance with influencing factors speed wave seismic that is depth, where the velocity of the first layer is greater than speed layer second, the thing This because the material on layer lower will experience greater pressure than the layer above it, this greater pressure causes the rock to become denser, which is also characterized by small porosity. The difference speed on every track influenced by There is his difference density And porosity on every track so that speed wave seismic on each - each track different, things This depends type layer lower the surface contained under surface earth. Based on processing carried out, the results obtained are in accordance with the conditions of the geological map where the Bukittinggi area consists of eroded Qpt layers and alluvial deposits are also found, this This in accordance with geology Bukittinggi based on [18]. based on research conducted [19] state that layer weathered with thickness more from two meters potential experience movement land so that can it is said on all track No stable, which can cause movement land, movement land This can happen on steep slopes or cliff river resulting from by weathering [20].

IV. CONCLUSION

Based on the results of seismic refraction data collection in the Tabiang Barasok area, 3 layers of subsurface layer models were obtained. The wave propagation velocity values in layer 1 were sequentially 218.05 m/s, 300.43 m/s, 222.75 m/s, and 314.35 m/s, while for the second layer, the wave propagation velocity in each layer was 447.64 m/s, 627.44 m/s, 327.12 m/s, and 541.87 m/s. At layer first on paths 1 and 3 are obtained sand not saturated, whereas on paths 2 and 4 are obtained layer weathered. On layer second paths 1 and 3 are obtained layer weathered as well as gravel not fed up and on layer second Alluvium was found on tracks 2 and 4. Based on this, the results obtained on every track there is layer which one is rotten layer weathered with thickness more from 2 meters can cause happen his movement land, movement land can happen on very steep slope steep or cliff river resulting from by weathering. Results study This can utilized by public.

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