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Analysis of Area Potential Landslides on Elak Roads Using Geoelectrical Methods

M.Fauzan[1], Syafrizal[2], Deassy Siska[3*], Khalsiah[4]

[1]Civil Engineering, Engineering Faculty, Universitas malikussaleh, Aceh Indonesia
[2]Physics, Faculty of Teacher Training and Education, Universitas Malikussaleh, Aceh, Indonesia
[3]Physics, Faculty of Teacher Training and Education, Universitas Malikussaleh, Aceh, Indonesia*
[4]English, Faculty of Teacher Training and Education, Universitas Malikussaleh, Aceh, Indonesia

*Corresponding Email: [3]*deassy@unimal.ac.id*

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Abstract: A landslide is a geological event that occurs when rock masses move together. The combination of high rainfall and steep topography and weathered rock creates a landslide-prone environment The many deformations and cracks along Jalan Lintas Elak indicate that the area is prone to landslides. This condition is unquestionably linked to the lithological conditions beneath the surface: Resistivity data measurements were carried out using the electrical resistivity method of the Wenner-Schlumberger array on two-line with a length of each line of 220 m to determine these conditions. The presence of a weak zone with shallow resistivity values (1 - 4 m) located at a depth of 5 - 16 m caused the liquefaction that occurred on the ELAK1 at a distance of 84 – 148 m, according to the results of the cross-sectional resistivity model processed using the Res2DInv software. At a distance of 85–156 meters on the ELAK2, a barrier of sand, gravel, boulders, and clay causes soil subsidence and deformation. This occurs because there is a weak clay rock layer with a resistivity value of (5 m) at a depth of 9 m and the tunnel's location

Keywords: Resistivity, Elak Road, Landslide

1. INTRODUCTION

Landslide is a geological event that often occurs due to the movement of rock masses in areas with steep topography, weathered rocks and high rainfall. Landslides often take lives or cause damage. Landslides that occur on the road, for example, can result in the interruption of access to traffic lanes, causing losses. Potential areas for landslides can be studied by direct observation of the surface appearance or using measuring tools in the field of geophysics to see below the surface.

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In North Aceh, the Elak road is one that has a lot of potential for landslides. Even in some locations these landslides have occurred repeatedly. This can be seen directly in several sections of the road, where the road has been damaged due to rock deformation, creeping soil, and weathered soil. Meanwhile, to find out more clearly the subsurface conditions related to saturation, rock density or the depth of the slip plane, geophysical methods must be used. One of them can use the Wenner-Schlumberger array resistivity geoelectric method. Measurements using this configuration will obtain variations in rock resistivity in the lateral and vertical directions which can be modeled in the form of a 2D cross-section, so that it can provide a current picture of the subsurface area of the potential landslide location on Jalan Elak based on the value of these physical parameters.

2. RESEARCH PURPOSES

This study was conducted with the aim of knowing the present subsurface conditions on the Elak highway in an effort to see the relationship between saturation and rock density that causes road damage. The results obtained can be used as an initial reference in explaining the influence of subsurface rock conditions as the cause of landslides at several points along the Elak road. Where these results can also be used as a reference by related parties in efforts to handle landslide potential locations on the Elak causeway.

3. LITERATURE REVIEW

1. The research location for the landslide potential area on the Lintas Elak road is administratively located in North Aceh Regency, Aceh Province.

Figure 1 Research Locations Based on Google Earth Image

2. Landslide is the movement of slope-forming material in the form of rock, debris, soil, or a mixture of these materials, moving down or out of the slope. The process of landslides

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can be explained as follows. Water that seeps into the soil will increase the weight of the soil. If the water penetrates to the impermeable soil which acts as a slip plane, then the soil becomes slippery and the weathered soil above it will move along the slope and out of the slope (Rusydy, GEO- DISASTER, 2021).

3. Geoelectricity is one of the geophysical methods to determine changes in resistivity (resistance) of rock layers below the ground surface by flowing an electric current that has a high voltage into the ground. This electric current injection uses electrodes that are plugged into the ground with a certain distance. The longer the electrode distance will cause the flow of electric current to penetrate deeper rock layers. Geoelectric measurement consists of several methods, including self-potential (SP), telluric and magnetotelluric currents, resistivity, electromagnetic (EM) and polarization induction (IP) can be applied to detect underground cavities or caves (Idris, Marwan, et al. Fadhli, Rusydy, & Munir, 2018)

4. Rock Resistivity, In general, based on their electrical resistivity, rocks and minerals can begrouped into three, namely:
Good Conductor : 10-8 < ρ < 1 ΩmSemi-Conductor : 1 < ρ < 107 Ωm
Isolator : ρ < 107 Ωm (Telford et al., 1990).

5. Resistivity of rock containing water in general depends on many physical parameters such as porosity, salinity, temperature, rock conductivity and thermal changes. On the one hand, the porosity and saturation of the fluid tend to be dominant in resistivity measurements, on the other hand, fracture pores in rock crystals can also reduce the resistivity value contained in the fluid. The dependence of the resistivity value on the rock:
a. The higher the water content, the lower the resistivity value.
b. The higher the salinity, the lower the resistivity value.
c. The higher the temperature, the lower the resistivity value.
d. The higher the porosity, the lower the resistivity value.
e. The higher the nature of the clay content, the lower the resistivity value.
f. The higher the content of metallic minerals, the lower the resistivity value (Telford, Geldart, & Sheriff, 1990).

4. METHODS

Geoelectric measurements for the analysis of potential landslide areas on the Elak highway have been carried out in two lines, namely the ELAK1 and the ELAK2. The length of each measuring line is 220 m. An overview of the two tracks can be seen in the table below.

Table 1. The coordinates of the lines electrical resistivity measurement

No.	Line	Latitude/Longitude	Latitude/Longitude
		0 m	220 m
1	ELAK1	07'43.63"N 97° 8'4.69"E	07'43.61"N 97° 8'11.83"E

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2	ELAK2	07'43.98"N	07'45.27"N
		97° 8'26.28"E	97° 8'33.38"E

The stages in this research consist of field orientation based on geological maps and google earth images, initial survey of the research site (geological survey), measuring data using the geoelectric method, data processing, and interpretation

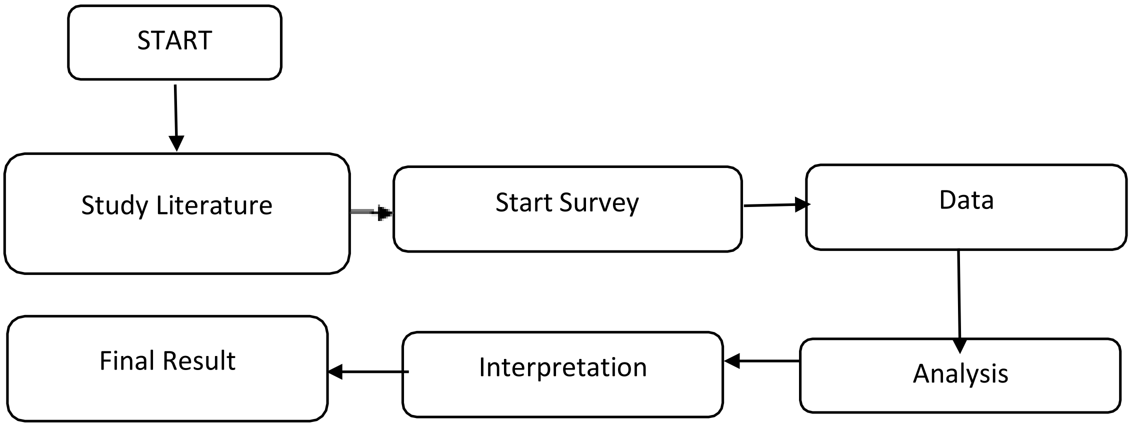

Figure 2. Stages Research

Data Collection Techniques

The data acquisition process in this study used a Super Sting R8/IP resistivitimeter and a Winner Schlumberger configuration. At each location, data collection was carried out in 2 tracks with a track length of 220 m.

Figure 3. Super Sting R8/IP Resistivity meter Equipment and attributes

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5. RESEARCH RESULT

The geology of the study area based on the geology of the Lhokseumawe quadrangle (Keats et al., 1981) is included in the Idi formation. The Idi Formation consists of semi consolidated gravels, sands, limestones and clays. Several outcrops around the study site also show gravel insertion in the clay layer.

Figure 4 Measurement Process Using Resitivitimeter On ELAK1

Figure 5 Measurement of Data on Line ELAK2

The results of the cross-section of the 2D resistivity values obtained after processing the datausing the Res2DInv software on the two paths are as follows:

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1. ELAK1

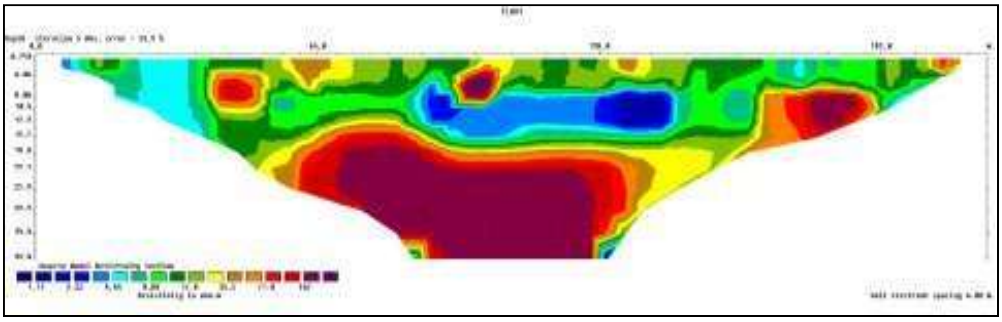
Figure 6. ELAK1 Resistivity Cross-section.

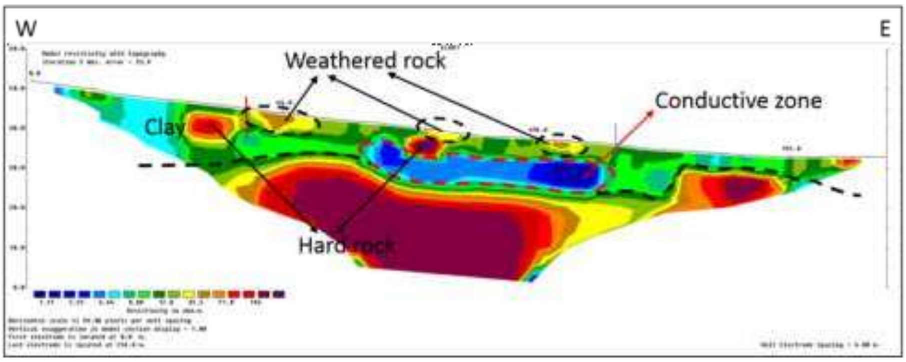

Figure 7. ELAK1 Resistivity Cross-section.with Topography

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Kirim masukanPanel samping

2. ELAK2

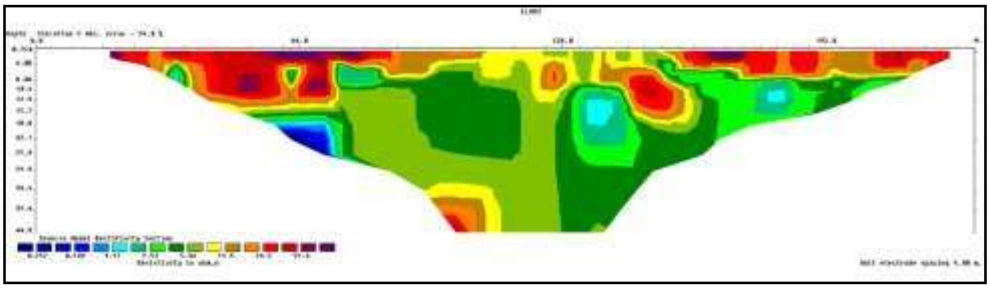
Figure 8. ELAK2 Resistivity Cross-section.

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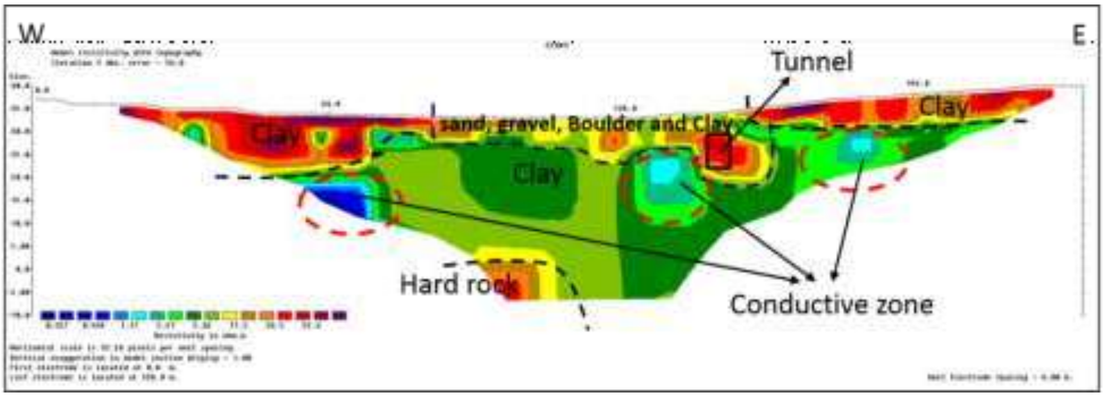

Figure 9. ELAK2 Resistivity Cross-section.with Topography.

6. CONCLUSION

The resistivity cross-section obtained shows that:

1. The ELAK1 path has the potential for deformation and soil subsidence at a distance of 84 – 148 m due to a weak zone with a low resistivity value (1 – 4 m) is found at a depth of 5-16 m.

2. On the ELAK2 trajectory, soil subsidence and deformation can also occur in the embankment rock area, which is at a distance of 85 – 156 m. This can happen because at a depth of 9 m below the rock layer, the tunnel's location is a weak clay rock layer with a resistivity value (± 5 m). The high conductivity of this layer is because on the south side of the track, there is a large puddle of water.

ACKNOWLEDTGMEN

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