Determination of Slip Surface Using 2D Geoelectric Resistivity Method and Laboratory Analysis for Landslide Prone Area Pesawaran, Lampung

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Abstract. Padang cermin sub district is the only access to beach tourism in Pesawaran District, which is the main tourist destination in Lampung. Along Padang cermin road consists of cliffs and hills that are vulnerable to landslides, so it is necessary to study the vulnerability of landslides in the area. 2D geoelectric measurements have been carried out in the Padang cermin area to find out the resistivity values that can be used to determine the land that makes up the slope and the skid plane. From the measurement results it is found that in the Padang cermin area there are five layers of soil in a row namely clay, clay sand, Alluvium, Sandstones and limestone. Slip surface area is at the boundary between the fourth and fifth layers at a depth of 39m.

1. Introduction
Landslide is one of natural hazard that affect humans and their livelihood especially in the mountainous area. landslide is generally defined as the movement of rock, debris and soil down to slope driven by gravity and preconditioned by the landform. Landslides can be classified into different categories depending on the types of materials (earth, rocks and debris) involved and the types of movements (fall, topple, slide, spread and flow); for example, rock fall and earth flow. Steepness of slope, morphology, soil type and underlying geology are the most important factors for causing landslides [1].

Landslide is the most common disaster in the tectonic area Indonesian and particularly occurred in raining season [2-6]. In 2019 the landslide is the second largest disaster that often occurs in Indonesia after a tornado, with a total of 550 times that affected more than five thousand people [7].

There are many methods to analyzing landslides, one of which is using 2D geoelectric resistivity method. by using 2-D resistivity method we can obtained identifications of boulders locations, bedrock depth, presence of overburden materials, saturated zones, earth work related to the leachate migration, groundwater sources and contamination, cavity, sinkhole and other [1,8-10].

In this paper we measure the resistivity of the soil Pesawaran Prone Landslides area to determine the type of soil slope. Padang cermin district is the only access to beach tourism in Pesawaran District, which is the main tourist destination in Lampung. where along the Padang cermin road are cliff areas and hills that are prone to landslides. By knowing the value of resistivity we can find out where the location and shape of the slip surface so that we can analyze the level of landslide vulnerability.

2. Study Area and Method
Topography or condition of the earth's surface Pesawaran Regency is a low-lying area, and a plateau, which is partly a hilly to mountainous area with a height from sea level that varies between 0.0 m to
1,682m. The topographic shape of the Pesawaran Regency is based on the slope can be divided into 2 parts namely 0 - 8% and > 40%. While the topography > 40% is 35,394.05 spread in Padang Cermin District [11].

Figure 1. Location of landslide prone area, Padang Cermin district, Pesawaran, Lampung.

Along the road to the coastal tourist area in Padang Cermin district, Pesawaran, Lampung a cliff area that is prone to landslides (Figure 1). To analyze the components of the slope and to find the sliding plane, a 2D geoelectric measurement is performed. Geoelectric data collection is done by dipole-dipole configuration with 32 electrodes and the distance of each electrode is 6m.

3. Result and Discussion
After processing the measurement data using the Res2Divn application, it is obtained a cross-sectional subsurface image of the B trajectory, with a length ±180 m and distance between the electrodes as far as 6 meters as shown below.
Figure 2. Cross section resistivity, Padang Cermin district, Pesawaran, Lampung.

From this figure, it can be seen that the subsurface cross section of path B is composed of five layers with values of specific resistivity 0.165 Ωm, 0.976 Ωm, 5.76 Ωm, 34.0 Ωm, 201 Ωm, 1187 Ωm, 7010 Ωm, and 41401 Ωm visualized by the color is different for each type of resistivity value.

The first layer with resistivity values of 0.165 Ωm-5.76 Ωm at depths of 1-10 meters is thought to be the same layer, which is the clay resulting from the erosion of Mount Ratay deposition according to the regional geological map of Pesawaran.

For the next layer, the second layer with a resistivity of 34 Ωm at a depth of 10-27 meters, it is assumed that it is a layer of clay sand. The third layer with 201 Ωm resistivity at a depth of 27-35 meters is thought to be an Alluvium layer which has a resistivity of 10-800 Ωm.

But the resistance value of the third and fourth layer types has a striking difference. The striking difference in resistivity values between the two layers is thought to be a different layer due to differences in density and water absorption of the layer.

So the fourth layer is thought to be a layer of sandstones (sandstones) which have a resistivity value of 200-5000 Ωm found at a depth of 35-39 meters, while the fifth layer is thought to be a layer of limestone with a layer depth of ± 39-43 meters or with a thickness 4 meters.

Slip of the 5 layers found in path B with different layer thicknesses and depths, this limestone layer is thought to be a slip plane with a thickness of about ± 4 m (depth observed at 80 m). This is because the layer has a much higher resistivity value compared to the other layers. This shows the layer is a layer that is more waterproof than the other layers. Layers that contain more water will have smaller types of resistance.

Figure 3. Slip surface, prone landslide area Padang cermin district, Pesawaran, Lampung.

The limestone layer which is thought to be a slip plane on the track is marked by a black dashed line. If water seeps into the soil until it reaches the watertight limestone layer, it causes the layer to become slippery. So that the top layer will move down the slope and is known as a landslide.

4. Conclusion

Based on the result of the measurement, resistivity value range is 0.165-41401 Ωm. There are five layers of soil in a row namely clay, clay sand, Alluvium, Sandstones and limestone. Slip surface area is at the boundary between the fourth and fifth layers at a depth of 39m.

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