Slope investigation using integrated geophysical methods

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Abstract: Slope can be related with various factors before it can be determined its stability. From the engineering aspects which includes geotechnical parameter, the slope stability can be determined based on the slope angle and its steepness. The slope steepness can be grouped into three classes to determine the risk of landslide on hill-site development (Gue & Tan, 2004). However, the slope stability might not be affected only based on the steepness and the slope angle. It might also depend on the subsurface structure. Hence, the results obtained from geophysical methods were also important and need to ensure the slope stability. Seven 2-D resistivity and Self Potential survey lines were conducted with 1.5 m minimum electrode spacing and 3.0 m interval spacing respectively at Archaeology Gallery, Penang. The 2-D resistivity data obtained were transferred into the computer for further processing and was presented in 2-D resistivity inversion model via Res2Dinv and Surfer v8.0 software. While for SP method the data will be process using excel and presented 2-D and 3-D surface map using Surfer v8.0 software. The inversion models convey the subsurface structure on each line in which was represented by the resistivity values. The range of resistivity values were determined and classified into three classes for interpretation. The saturated zones, weathered granite and fresh granite were classified with range values of 1-400 Ωm, 1500-5000 Ωm and greater than 5000 Ωm respectively. The saturated zones were characterized by low resistivity and it also may indicate that the zones associated with the high water and clay contents and possible unstable fracture within the landslide mass (Göktürkler *et al*., 2008; Ronning *et al*., 2003) which were observed at topsoil at the study area. Low resistivity value (100-800 Ωm) might be alluvium which consist of sandy, silt and sand. The material that may cause landslide was unconsolidated characteristics may correspond to the resistivity lows with increasing moisture and fines contents (Drahor *et al*., 2006; Abidin *et al*., 2013). Subsequently, the results from SP method were used to verify the results of 2-D resistivity method. The directions and intensities of the water/high conductive were evaluated with self-potential (SP) method. Interpretation of SP support the results of 2-D resistivity method relating a saturated zone in the survey area. A zone that is fully saturated with sandy silt could be an influence factor the increasing water level because sandy silt is highly permeable in nature. There is a good correlation between the 2-D resistivity investigations and the results of SP. Other features such as presence of boulders was indicated by isolated high resistivity values, boulders overlie saturated zone and presence of fracture were also determined as indicated by the resistivity variations of the inversion models. These features can be the influence to trigger the landslide event in the early stages. Apart from precipitation as a major factor of the phenomenon, slope angle can also be one of the important factors to be aware to determine slope stability. Precipitation can affect the soil strength and texture while the slope angle can determine slope's class of landslide risk. This study area has been classified of having medium risk of landslide event.

Table 1: Summary of slope at Archaeology Gallery, Penang.

Criteria	Details
Type of soil	Presence of clay, silt and granite
Zones	consist saturated zones, weathered granite and fresh granite.
Factor cause to slope failure	Presence of saturated zone (1-400 **Ωm**), fracture, highly weathered granite, boulders and floaters (>3000 **Ωm**).
Slope steepness	Slope angle : 21˚
Sum of precipitation (Month)	105.11 mm (May-Oct 2016)
Class of risk for land-slide event	Class 2 – Medium risk

Keywords: Slope, 2-D resistivity, self-potential (SP), saturated, landslide

References

Abidin, Z., Hazreek, M., Wijeyesekera, D. C., Saad, R. & Ahmad, F., 2013. The influence of soil moisture content and grain size characteristics on its field electrical resistivity. Electronic Journal of Geotechnical Engineering, 18, 699-705.

Drahor, M. G., Göktürkler, G., Berge, M. A. & Kurtulmuş, T. Ö., 2006. Application of electrical resistivity tomography technique for investigation of landslides: a case from Turkey. Environmental Geology, 50(2), 147-155.

Göktürkler, G., Balkaya, Ç. & Erhan, Z., 2008. Geophysical investigation of a landslide: The Altındağ landslide site, İzmir (western Turkey). Journal of Applied Geophysics, 65(2), 84-96.

Gue, S.S., & Tan, Y.C., 2004. Guidelines for Development on Hill-Site. Tropical Residual Soils Engineering (TRSE), 6th–7th July 2004.

Ronning, J. S., Dalsegg, E., Elvabakk, H. & Storro, G., 2003. Characterization of fracture zones in bedrock using 2D resistivity. In 9th EAGE/EEGS Meeting.

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