Soil characterization using integrated geophysical methods at Sungai Batu, Kedah

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Abstract: Heterogeneity and variations in subsurface environments necessitated detailed geological and geotechnical investigation in order to provide a useful and comprehensive information. This alluvial material characterized by loose, unconsolidated soil/sediment that commonly investigated by the conventional geotechnical method. The conventional method such as borehole provided an excellent measurement of the soil characteristic of particular location however due to heterogenous of fractured rock system with a greater volume it may not possible to extrapolate with a single measurement. The geophysical approach is needed to overcome this problem for the large area besides decrease the environmental damage, time, and cost (Muztaza *et al*., 2012; Abu Samah *et al*., 2016). The paper briefly introduced the applied geophysical method in subsurface characterization with validation of geological and geotechnical information. Generally, this area is underlain by Mahang Formation with the rock unit comprise shale, red slate, grey slate and black slate (Jamil *et al*., 2004). Granitic intrusion causes the rocks of surroundings area to become metamorphose to produce schist rocks with formation formed in Middle Ordovician to Early Devonian age (Bradford, 1970). Six survey lines; L1, L2, L3, L4, L5 and L6 with length of 800 m, 400 m, 540 m, 1400 m, 200 m, 200 m respectively were conducted with utilizing SAS4000 system for data acquisition while two lines, L1 and L2 of seismic with length of 200 m and 230 m are recorded using seismograph ABEM Terraloc MK8 with 24 unit of vertical geophones as a detector. The resistivity data were processed using Res2Dinv and Surfer8 software for inversion process and data imaging. The first arrival of seismic waves was picked, and 2-D profile is generated using SeisOpt@2D. A region with low resistivity values of 50-150 Ωm was interpreted as the clay and sand while saturated zone was identified with resistivity values of <100 Ωm. A region with resistivity of >100 Ωm was interpreted as loose and dry alluvium while high resistivity value of >800 Ωm interpreted as shale layer as closed agreement with geology information. The seismic refraction result identified the first, second and third layers with a velocity of 400-1400, 2000-3400 m/s and >3600 m/s respectively. A top layer shows a high velocity as SPT-N values increase with depth. A layer with a velocity of 2000-3000 m/s interpreted as the compacted material is closed an agreement with borehole record which shows at depth 5-15 m the lithology consists of hard clay, quartz pebble, and also shale layer. The correlation with the borehole, BH 1 record which is in line with profile line of L1 shows at depth <5 m the stratigraphy shows clay dominated as it is stiff and plastic with the presence of fine grain sand. This shows the velocity recorded at this layer are higher at <1400 m/s and resistivity of <30 Ωm with the SPT N- values of 6-7. Cross-correlation of 2D resistivity and seismic refraction shows the lithology of this locality is being dominated by the clay deposit with the shale layer represent as hard layer as SPT-N values reach up to 70 blows with resistivity and velocity values >800 Ωm and >3600 m/s respectively. Table 1 shows the summary of standard resistivity and seismic values for this locality.

Table 1: Standard resistivity table in Sg.Batu.

Soil types	Resistivity, ρ (Ωm)	Velocity, V_p (m/s)	SPT-N
Clay	<30	400-1400	6-60
Saturated clay	50-150	2000-3400	9-27
Shale	800	>3600	26-70

Keywords: Sungai Batu, 2-D resistivity, seismic refraction, geotechnical, borehole

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