Physico-chemical and mineralogical properties of basalt soils from Segamat, Johor

TAN BOON KONG AND ANIZAN ISAHAK

Department of Geology
Universiti Kebangsaan Malaysia
43600 Bangi

Some twenty basalt soil samples from the Segamat area were analysed for their physico-chemical and mineralogical properties. The physical properties of the soils analysed are: relative density, water content, Atterberg Limits, grain size distribution, and compaction properties. The chemical properties analysed involved pore fluid chemistry, whereby the pore fluid of the soils were first extracted using the "Saturation Extract" method, and then subsequently analysed for pH, electrical conductivity, cation (Na^+, K^+, Ca^{++}, Mg^{++}) concentrations and anions (SO_4^{2-}, Cl^-) concentrations.

The result for the physico-chemical properties of the Segamat Basalt soils are summarised in Table 1. For simplicity, only the range of values of the various physico-chemical parameters are shown. The results show the following characteristics for the Segamat Basalt soils: relative density is high, i.e. up to 2.98, with many values exceeding 2.70; water contents are generally high with $w_o > 30\%$, up to about 40% indicating high absorption of water; liquid limits are all > 50% (high), with many values in the 70–80% range; grain sizes are predominantly fine-grained, namely M/C, though there are significant amounts of S as well. While most fine-grained soil samples do not contain any gravels (G), the gravel layer in the Segamat Basalt soil profile contains high gravel (G) contents (G = 30–67%); the fine fractions of the soils are classified as MH soils, i.e. silts with high plasticities (LL > 50%); the compacted maximum dry densities are mostly low, i.e. < 1.50 g/cm^3, although several samples show high γ_{dmax} of ~1.70–1.80 g/cm^3; the optimum moisture contents (ω_{opt}) are also generally high (> 30%) and these high ω_{opt} values could account for the generally low γ_{dmax} values obtained.

Results for the pore fluids chemistry indicate the following: pH is < 7 (except for 3 samples only), i.e. slightly acidic; conductivity is low, reflecting the low cation contents of the pore fluids; cations Na^+, K^+, Ca^{++}, Mg^{++} are generally low in concentrations, with K^+, Ca^{++}, Mg^{++} all having values of < 5 ppm; Na predominates over the other cations, with values of 7–20 ppm, thus the ratios of monovalent ($Na^+ + K^+$) versus divalent ($Ca^{++} + Mg^{++}$) cations show high values of >> 2. Both SO_4^{2-} and Cl^- anions show significant concentrations. Some variations in the plasticity of the different portions of the Segamat Basalt soil profiles appear to exist, as evidenced from the plot on the plasticity chart.

Mineralogical studies of selected samples using XRD and TGA methods show that the main minerals in the clay fraction of the soils are kaolinite and goethite.

Table 1. Summary of physico-chemical properties of Segamat Basalt soils.

Physical Property	Range of Values	Chemical Properties	Range of Values
Relative Density (Gs)	2.54–2.98	pH	6.09–7.13
Water Content (%)	11.65–40.64	Electrical conductivity ($mS.cm^{-1}$)	0.083–0.552
		Ion content:	
Atterberg Limits:		Na^+ (ppm)	7.3–21.5
LL (%)	50–84	K^+ (ppm)	1.23–7.39
PL (%)	29–44	Ca^{++} (ppm)	0.40–7.23
PI (%)	21–40	Mg^{++} (ppm)	0.08–6.77
		SO_4^{2-}(mg/l)	20–50
Grain size distribution		Cl^- (mg/l)	3.8–45.8
G (%)	0–67		
S (%)	4–56		
M (%)	4–61		
C (%)	5–64		
Compaction:			
γ_{dmax} (g/cm^3)	1.26–1.80		
ω_{opt} (%)	20.0–44.0		
Classification (fine fraction)	MH		
Sodium Adsorption Ratio (SAR)	1.03– 3.71		