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SCIENCE DIRECT
Engineering Geology 85 (2006) 197–203
ENGINEERING GEOLOGY
www.elsevier.com/locate/enggeo

Effect of pH on the geotechnical properties of laterite

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Accepted 15 September 2005
Available online 17 April 2006

Abstract

Environmental Geotechnology has emerged as an interdisciplinary science, aiming and forecasting, analyzing and solving the geotechnical problems involving the influence of environmental factors. Lateritic soil of west coast region of India was studied to investigate the effect of soaking on the engineering properties and chemical characteristics of soil, soaked in different pH solutions (pH=5.0, pH=7.0, pH=8.0). 12 N hydrochloric acid and 15 M ammonia solution were used to monitor the pH of the solution for about ninety days. Results showed that the pH of the solution has strong influence on the chemical characteristics of lateritic soil. The engineering properties of soil are altered when compared with the initial characteristics of the soil. The reason for this observed behavior of the soil is addressed in this paper.

Keywords: pH; Lateritic soil; Chemical characteristics; Compressive strength; Leaching; Cations

1. Introduction

In recent years Environmental Geotechnology has emerged as an interdisciplinary science, aiming and forecasting, analyzing and solving the geotechnical problems involving the influence of environmental factors (Manassero and Deangeli, 2002). Soil pollution arises from variety of sources, which includes acid rain, unscientific method of waste disposal etc. In recent years much attention has been paid to acidification of rain, which is one of the environmental factors which will affect the properties of soil. Kamon et al. (1996) investigated the variation of the engineering properties of lime and cement stabilized soils when acid rain falls over a long period of time. Infiltration and soak tests were conducted at different pH levels of artificial acid rain to experimentally simulate the erosion process on stabilized soils. Gupta and Singh (1997) reported that the hydrogen ion concentration in the soil influences all chemical reactions and biological activities. Stalin and Muthukumar (2002) reported that the atmospheric

Table 1
Initial characteristics of lateritic soil

γ_d (kN/m^3)	16.87
w_n (%)	16.12
w_L (%)	42.00
w_p (%)	33.33
I_p (%)	8.67
w_s (%)	24.45
I_s (%)	8.88
Gravel (%)	36.40
Sand (%)	57.40
Silt (%)	5.00
Clay (%)	1.20

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doi:10.1016/j.enggeo.2005.09.039

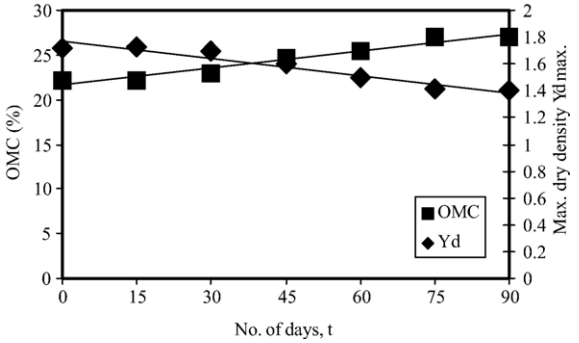

Fig. 1. Variation of maximum dry density and optimum moisture content with time (pH maintained as 5.0).

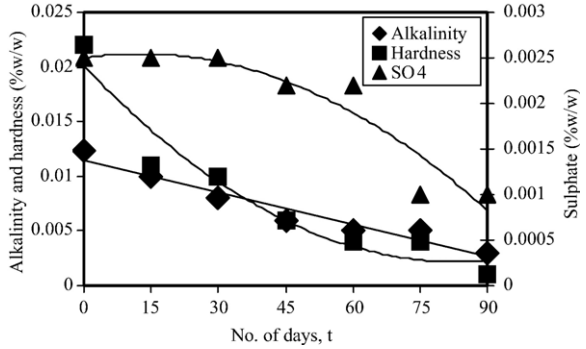

Fig. 2. Variation of alkalinity, hardness and sulphate in soil with time for soaking of laterite soil blocks (pH = 5.0).

pollution has resulted in the precipitation having pH less than 5.6 which resulted in acidification of soils and thus altering the physical and engineering properties. Very little research has been conducted to determine the behavior of laterite soil soaked in solution of different pH. The study aims in bringing relevant conclusions of the behavior of laterite.

2. Methodology

The laterite soil blocks (40 × 20 × 20 cm) used in this study were obtained from sites nearby Surathkal. The wet strength of laterite blocks was determined in the laboratory as per Bureau of Indian Standards (BIS, 1987, 1988). The crushed material was oven dried sieved using 20 mm IS sieve. The down size material is used for sample preparation. The consistency properties of laterite soil were determined for the soil fraction passing 425 μm sieve. Representative soil passing 20 mm IS sieve was used to obtain the dry density moisture content relationship by standard Proctor compaction test. The chemical analysis of lateritic soil was done for the soil fraction passing 425 μm sieve. The initial characteristics of the lateritic soil collected at 1 m depth are summarized in Table 1. The initial chemical characteristics of lateritic soil are summarized in Table 3. All the chemical tests conducted are as per the Standard Methods (APHA et al., 1998).

Table 2
Variation of specific gravity

	pH maintained as 5.0	pH maintained as 7.0	pH maintained as 8.0
Initial (unsoaked)	2.55	2.55	2.55
15 (days)	2.54	2.30	2.50
30 (days)	2.50	2.30	2.50
45 (days)	2.38	2.30	2.50
60 (days)	2.23	2.30	2.35
75 (days)	2.26	2.30	2.34
90 (days)	2.21	2.23	2.26

3. Experimental procedure

Laterite soil blocks were soaked in three tanks (1.2 × 1.2 × 0.6 m) C_1, C_2, C_3. The initial characteristics of water in which laterite soil blocks were soaked are summarized in Table 5. In tank C_1, pH was maintained as 5.0 and in tank C_2 and C_3 the pH was maintained as 8.0 and 7.0. The pH of the water was monitored daily using pH meter. The pH of the water in the tanks was maintained constant (for soaking period up to ninety days) using 12 N HCl and 15 molar ammonia solution. Also certain other parameters like alkalinity, chloride, electrical conductivity, hardness and sulphate were analyzed daily (up to ninety days). At the end of fifteen days six laterite blocks from each tank were tested for compressive strength in compressive testing machine. The crushed material was oven dried and sieved using 20 mm IS sieve. Similar procedure of sample preparation was followed for all the samples.

4. Moisture–density relationship

Fig. 1 illustrates the relationship between maximum dry density and OMC with time. It is observed from Fig. 1 that maximum dry density decreases and OMC

Table 3
Initial chemical characteristics of lateritic soil

pH	5.21
EC (μS/cm)	93.20
Chlorides (%w/w)	0.018
Alkalinity (%w/w)	0.0124
Hardness (%w/w)	0.031
Sulphate (%w/w)	0.0014
Nitrogen (%w/w)	0.0036