Effect of pH on Compressibility Behaviour of Cement Treated Soils

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Abstract
This paper presents a detailed review on to enrich the performance of structures, the stability of underlying soils must be checked. The stability of soil may change due to the discharge of pollutants leading to the changes in the pH of water. In the present study, the black cotton soil was treated with Ordinary Portland Cement(OPC) of 53 grade with different percentages(3%,6% and 9%) and laboratory tests such as Atterberg Limits, Compaction and Unconfined Compressive Strength(UCS) were performed. Tests were conducted to assess the effect of pH (pH=5,pH=7 and pH=9) on treated soil properties with different curing periods(7,14 and 28 days).The aim of this study is to establish the effect of acidic and alkaline nature on curing time behaviour of cement treated soil.
Keywords: black cotton soil; pH; Ordinary Portland Cement.

Introduction

Generally, industries are the main source for human life and developing countries. Due to the increase in the industrial activities, the waste which has been released from these industries causes enormous changes. In most of the developed countries, among 70% of solid and liquid wastes are dumped into water bodies without appropriate treatment, due to which the ground water is getting polluted. The contaminated water contains heavy metals which creates problems in environment, due to which the pH of water may vary. If pH level of water is less than 7, it comes under acidic water and if it is greater than 7, it comes under alkaline water. Changes in the pH of water may affect the soil which leads to geotechnical problems. The reduction in strength properties may be found because of the mineralogical changes in the behaviour of soil. Mostly, expansive soils are the most problematic soils that exert pressure on the foundation or basement, which results in lateral moment of the structure. These soils become sticky when they absorb water, and become hard and brittle when they are in dry state. This can be avoided by improving the properties of soil which further increases its strength, stiffness, etc. To accomplish higher strength, stabilization can be used by adding different additives. The technical information about cement treated soil mixtures has been carried out from various research works in the past.

Soil Stabilization

The term soil stabilization means the improvement in the properties of poor soils by the use of controlled compaction proportioning and the addition of suitable admixtures or stabilizers. Soil stabilization deals with mechanical, chemical methods to make the stabilized soil serve its purpose. The stabilization process essentially involves excavation of in-situ soil, treatment to the in-situ soil and compacting the treated soil. As the stabilization process

involves the excavation of the in-situ soil, this technique is ideal for improvement of soil in shallow depths such as pavements.

Scope Of Study

This study aims at investigation of various properties of Black Cotton soil such as the Atterberg limits, Swell Index and the compressibility characteristics.The soil is then treated with Ordinary Portland Cement (OPC) of 53 grade with different percentages (3%, 6% and 9%), and various laboratory tests have been performed to assess the effect of Ph (5, 7 and 9) levels on curing time (7,14 days) and behaviour of cement treated soil by conducting the Unconfined Compression Strength (UCS) test is studied.

Related Works – A Detailed Literature Review

Strength behaviour of clay cured under stress

In this investigation, Rushra,I., Robinson,R.Gmade an attempt to study the strength behaviour of cement stabilized marine clay cured under stress.

Soft grounds have low bearing capacity & high compressibility.

The unconfined compression test with and without using stress was conducted with

Cement content range of 10%, 15% and 20%.

Curing time of 28 days.

Curing stress adopted was 50, 100 and 200 KPa for samples at a depth of 5m, 10m and 20m respectively.

The conclusions made from this study are:

Curing time increases strength with cement content.

15% cement content was found to be more effective.

Substantial improvement in strength was found with cement content beyond 10% .

Durability of treated soil using lime and cement

HadjBekki ,ZahiaDjilani , YoucefTlidiji and Tahar H. Daouadjimade a comparative study of bearing and sustainability of silty soils treated with lime and cement was made to provide a solution for poor geotechnical soils used in road construction, as sub-grade layers, which fits sustainable development.

Soil Consistency, durability and bearing tests were conducted which gave the following conclusions:

Improvement in workability.

Greatest CBR value was obtained at 1% lime and 4% cement combination, thereby ensuring durability of pavement layers.

Geotechnical properties of cement based composite fine-grained soil

Sarkar, G., Islam, M.R., Alamgir, M., &Rokonuzzaman, M. conducted a Study on the geotechnical properties of cement based composite fine-grained soil.

They concluded that,

Partially saturated clayey soils (expansive soils) which are highly plastic show high volume changes to variation in water content.

Damages like cracks develop under continuous loading, due to low shear strength and cause failure. Hence, soil is stabilized with cement.

Compaction strength and deformation characteristics of Portland cement treated soils are studied.
Compaction test, consolidation test, unconfined compression test, Standard Proctor test were conducted and Atterberg limits were determined. The conclusions made were:
Decrease in Maximum Dry Density, increase in Optimum Moisture Content, compressive strength, liquid limit, plastic limit values.
The naming of soil changes from clay to silt due to pozzolonic behaviour of cement.
From the consolidation test, values of compression index decreased with the increases of cement content and initial void ratio increases for the cement treated soil.

Discussion And Analysis On The Review Of Study Made
Properties Of Soil

Specific gravity	1.78
Free swell index	110 %
Liquid limit	102.97%
Plastic limit	53.02%

Table 4.18 Properties of Black Cotton soil

- DRY SIEVE ANALYSIS :

  Gravel = 2.4%
  Sand = 3.946%
  Fines = 93.5%

Hence, the soil was classified as fine grained soil.

- WET SIEVE ANALYSIS :

From wet sieve analysis, the soil was classified as CH(Inorganic clay of high compressibility).

Results Of Omc &Mdd :

%AGE OF CEMENT MIX IN SOIL	**OMC (%)**	**MDD (g/cc)**
3%	12.5	1.44
6%	30	1.44
9%	40	1.29

Table 4.19 Results of OMC & MDD for treated soil

Results Of unconfined Compression strength Test :

pH	Cement content	7 days curing time (kg/cm^2)	14 days curing time (kg/cm^2)
5	9%	3.08	3.70
	6%	2.23	3.56
	3%	2.64	3.01
7	9%	3.98	4.82
	6%	3.76	4.79
	3%	3.10	3.90
9	9%	1.98	2.64
	6%	1.86	2.43
	3%	1.19	1.94

Table 4.20 Results of UCS test for treated soil

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