EFFECTS OF ACIDS ON STRENGTH PROPERTIES OF BLACK COTTON SOIL

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ABSTRACT:

Industrial advances in agriculture and chemical industries has to lead to release of variety of pollutants into the environment contaminated the soil. Soil being contaminated by anthropogenic sources such as leakage from waste containment facilities, accidental spills and industrial operations. In this project report the effect of Sulfuric (H_2SO_4), Nitric (HNO_3) and Boric (H_3BO_3) acids on the strength characteristics of black cotton soil at varying percentage studied. Laboratory regent sulfuric, nitric and boric acids were used in concentration of 0, 2, 4, 6, 8, and 10 percents, the acid contamination of soil adversely affects the strength characteristics of soil. The strength characteristics of soil get altered when an acid compounds gets mixed with soil. Atterberg's limits, compaction characteristics, CBR test and unconfined compressive strength tests have been carried out. The results are indicative that compaction characteristics, CBR test and unconfined compressive strength are altered due to acid contamination.

Key Words: Black cotton soil, Atterberg's limits, compaction characteristics, CBR test and unconfined compressive strength

1. INTRODUCTION

Modern construction requires not only profound preliminary study of the foundation material, but also a thorough knowledge of the factors causing its changes in the life time of the structures supported by it. Behavior of any chemical or contaminant in the soil depends upon its properties and its interactivity with soil. The major sources of subsurface and surface contamination are land disposal of industrial, mining, agricultural wastes and accidental spillage of chemicals. Results of some studies indicate that the detrimental effect of seepage of acids and bases into subsoil can cause severe foundation failures.

Since constructions on black cotton soils cannot be avoided their properties are altered by many ways like mechanical, thermal, chemical and other means to make acceptable or rejected on contamination. The index and engineering properties of the ground gets modified in the vicinity of the industrial pants mainly as a result of contamination by the industrial wastes disposed. The major sources are the disposal of industrial water and accidental spillage of chemicals during the course of industrial operations. The leakage of industrial effluent in to subsoil directly affects the use and stability of the supported structure.

Industrial activity is important for economic growth of any country but simultaneously it produces large amount of waste. This waste can be in solid, liquid or gaseous form. This waste contains of acidic matter, alkalis, dyes, organic waste, toxic metals, etc., when such pollutant mixed with soil, geotechnical properties of soil gets changed due to soil-pollutant interaction. Thus, soil contamination or soil pollution is caused by the presence of xenobiotic (human made) chemicals or other alteration in the natural soil environment. It is typically caused by industrial activity, acid rain, accidental spills, agricultural chemicals, leakage in sewer liner from industries and residence, or improper disposal of waste. This adversely affects the behavior of natural soil mainly due change in anion and cation exchange capacity. Sridharan *et al.* (1981) has reported the heaving of sub grade soil due to the leakage of phosphoric acid. Masashi (1997) investigates that the increased rate of leaching of cation and absorption of H+, SO_4 2-, NO_3 -, PO_4 3- and CO_3 2- due to mixing of chemicals containing these ions alter physical, chemical and engineering properties of soil

In some cases, the sub grade soils can be treated with various materials to improve the strength and stiffness characteristics of the soil. Evolving new construction materials to suit various traffic and site conditions for economic and safe design is a challenging task in road construction. Effective utilization of local weak soils by impacting additional strength using stabilization methods enable reduction in construction cost and improved performance for roads. Hence the stabilization of sub grade pavements has been gaining popularity in the field of pavement due to its high versatility and flexible.

2. LITERATURE REVIEW

K. Madhavi, Dr. M. Kameswar Rao (2017) Soil which is a major and primary element for the construction is gradually leading to the degradation of its properties. This proposed study mainly aims to determine the depth of contamination with pollutants in the soil. To determine this the soil sample is tested by adding various contaminants and the study is carried by testing it for the various tests such as particle size analysis, swelling index, plasticity index, unconfined compression strength and the compaction are examined. Further the effects of soil properties with the contaminants are studied.

M AMULYA, CH R V PRASAD, P H P REDDY AND G K KUMAR (2015) Sub surface soil pollution by various processes with high concentration of contaminants can significantly alter geotechnical properties of soils causing unexpected failures of structures. Unexpected behavior of soil upon contamination with acid solution is one of the major challenges faced by the geotechnical

engineers. This paper is an attempt to understand the mineralogical and micro-structural changes occurring in black cotton soil by immediate interaction with sulphuric acid.

Ponnapureddy Hari Prasad Reddy, Chavali Rama Vara Prasad, Rakesh J. Pillai (2017) A series of laboratory one dimensional free swell tests were performed to study the behaviour of soil in acidic and alkaline environment. Three different concentrations of sodium hydroxide and sulphuric acid solutions were used as pore fluids to understand the influence of variable concentrations on the swell behavior of soil. The complexity in the swell behavior of contaminated soil was assessed by thoroughly investigating the mineralogy and microstructure alterations by carrying out X-ray diffraction analysis, Scanning electron microscopy and Energy dispersive analysis of X-ray at the end of interaction.

Sagar M Korwar Dr. Shivasharanappa G Patil (2017) Black Cotton Soil was stabilized with a mixture of acids and alkalis. Industrial advances in agriculture, chemical industries have lead to release of variety of pollutants into the environment contaminating the soil. The geotechnical properties of soil get altered when an acid and alkali compounds get mixed with soil. This paper reports the effect of sodium hydroxide, sodium Carbonate, sodium bicarbonate, and hydro - chloric acid on the compaction characteristics of black cotton soil at various molarities.

H.N.Ramesh and S.D. Venkataraja Mohan (2013) In recent years attention has been given to the acidification and alkalization of the soils to understand physico-chemical and Engineering properties. The effect of Sulfuric Acid and Orthophosphoric acid with Calcium Carbonate and Magnesium Carbonate treated soils is studied.

Sojil Jain and Rajesh Jain (2015) with the growth in industrial sector, pollution in the form of liquid, solid and gas gets increase. Industrial effluent discharges on the land get mixed with soil and effect geotechnical properties of soil. Here in this paper Sulfuric Acid, phosphoric acid and nitric acid are used in the different percentage of concentration ranging from 0% to 15% is mixed with soil, so as to synchronize it with industrial sewage containing acidic content.

Unconfined Compression Test

3. MATERIALS USED

In the present study the following materials are used

1. Black cotton soil
2. Sulfuric acid
3. Nitric acid
4. Boric acid

3.1 Black Cotton Soil

Table 3.1 Properties of black cotton soil

Soil Property	Value
Specific Gravity	2.46
Free swell Index	110
Gravel size	12
Sand size	26
Silt & Clay size	62
Liquid Limit, LL (%)	79.5
Plastic Limit, PL. (%)	26.6
Plasticity Index (%)	52.9
Soil type	CH
Optimum Moisture Content (%)	28%
Maximum dry density (g/cc)	1.42
Un-socked	1.13
Socked	0.42
Unconfined compressive strength	0.407 Kg/cm²

3.2 Sulfuric Acid:

Table 3.2 Physical and Chemical Properties of Sulfuric Acid:

Chemical name	H_2SO_4
Appearance	Clear, colorless liquid
Odor	Odorless
Density	1.8302 g/cm^3
Melting point	10.31°C (50.56°F)
Boiling point	337°C (639°F)
Acidity	-3, 1.99

3.1.3 Nitric Acid:

Table 3.3: Physical and Chemical Properties of Nitric Acid:

Chemical formula	HNO_3
Appearance	Colorless, yellow or red fluming liquid
Odor	Acrid, suffocating
Density	1.51g/cm3
Melting point	-42°C (-44°F)
Boiling point	83°C (181°F)
Acidity	-1.4

3.4 Boric Acid:

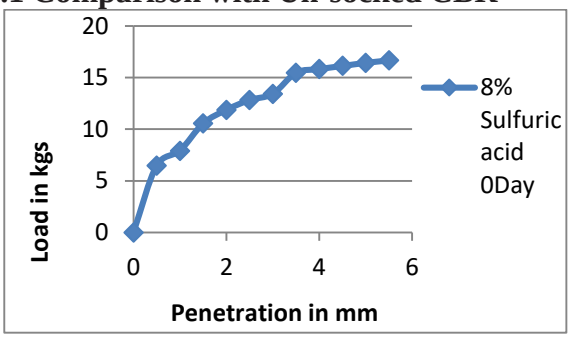
Table 3.3: Physical and Chemical Properties of Boric Acid:

Chemical Formula	BH_3O_3
Appearance	Amorphous
Density	1.435g/cm^3
Melting Point	170.9°C (339.6°F)
Boiling Point	300°C (572°F)
Acidity	9.24

4. RESULTS

4.1. Standard Proctor Test

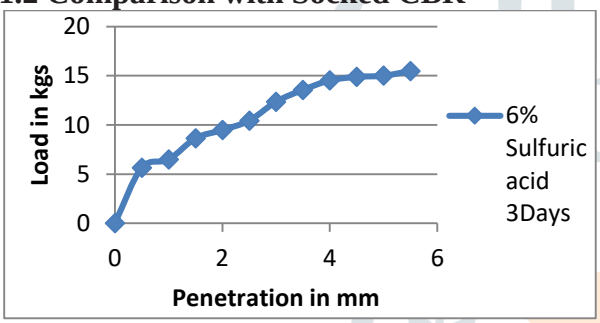
4.1.1 Comparison with Un-socked CBR



Graph 4.1.1 Penetration Vs Load for Un-socked test

Graph 4.1.1 represents a graphical represents a graphical comparison of Un-socked CBR high percent of Sulfuric acid 8% compared with Nitric and Boric acids.

4.1.2 Comparison with Socked CBR

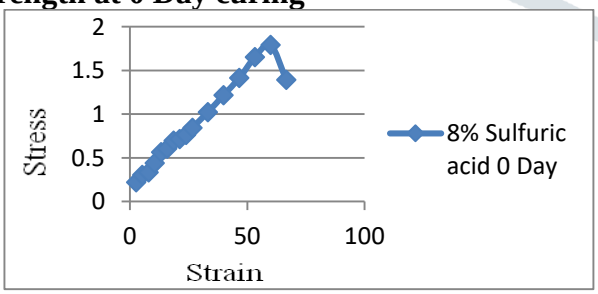


Graph 4.1.2 Penetration Vs Load for Socked test

Graph 4.1.2 represents a graphical represents a graphical comparison of Socked CBR high percent of Sulfuric acid 6% compared with Nitric and Boric acids.

4.2 Un-Confined Compression Strength

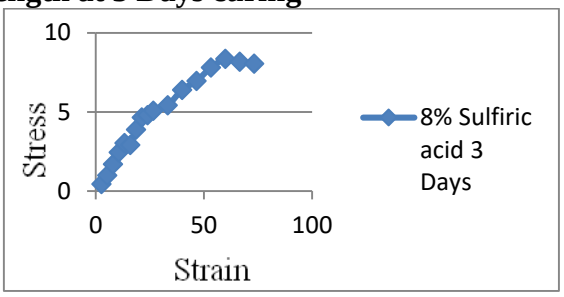
4.2.1 Comparison with Unconfined compressive strength at 0 Day curing



Graph 4.2.1 UCC Vs strain at 0 day curing

Graph 4.2.1 represents a graphical represents a graphical comparison better than shear strength observed percent of Sulfuric acid 6% compared with Nitric and Boric acids.

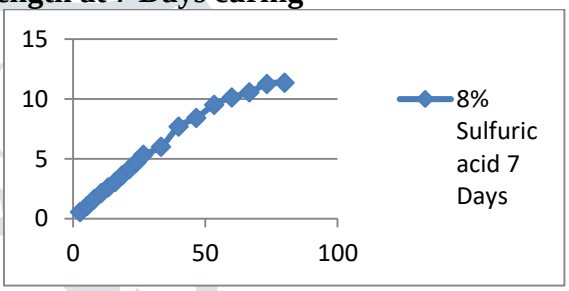
4.2.2 Comparison with Unconfined compressive strength at 3 Days curing



Graph 4.2.2 UCC Vs strain at 3 day curing

Graph 4.2.2 represents a graphical represents a graphical comparison better than shear strength observed percent of Sulfuric acid 8% compared with Nitric and Boric acids.

4.2.3 Comparison with Unconfined compressive strength at 7 Days curing



Graph 4.2.3 UCC Vs strain at 7 day curing

Graph 4.2.3 represents a graphical represents a graphical comparison better than shear strength observed percent of Sulfuric acid 8% compared with Nitric and Boric acids.

5. Conclusions

The admixtures are added to the soil in order to increase the strength of the soil. In this procedure we tried to increase the strength by adding the acids of different properties at different proportions.

In this project report the effect of sulfuric (H_2SO_4), Nitric (HNO_3) and boric (H_3BO_3) acids on the strength properties of black cotton soil at 0%, 2%, 4%, 6%, 8% and 10% percentages are studied.

The studies were carried out for Atterberg's limits, Standard Proctor test, California bearing ratio test and unconfined compressive strength and the result was as follows.

In **Atterberg's Limits** the tests were carried out at (0-2-4-6-8-10 %) of Sulfuric acid, Nitric acid and Boric acid.

When sulfuric acid was added to the soil it was observed that the Atterberg's limits were increased up to 6% and were decreased thereafter. When the soil was mixed with nitric acid it was observed that the results were increased up to 8 % and was decreased for 10% of nitric acid. When boric acid was mixed with the soil it was observed that the values were increased up to 8% and was decreased for 10% of boric acid.

From the above test results it was noted that the maximum strength of soil was increased at for sulfuric acid at 6% when compared with other acids.

The **Standard Proctor Test** was carried out for (0-2-4-6-8-10 %) of sulfuric (H_2SO_4), nitric (HNO_3), boric (H_3BO_3) acids.

When sulfuric acid was mixed with soil at different percentages it was found that the results were decreasing up to 4% and were increased from 6% up to 10%.When nitric acid was added to soil it was found that the results were increased up to 6% and were decreased thereafter. When the soil was mixed with boric acid it was found that the results were increased up to 4% and were decreased from thereafter.

From the above test results it was found that the soil attained its maximum strength with sulfuric acid when mixed at 10% when compared with other acids.

The **California Bearing Ratio Test** was conducted with different (0-2-4-6-8-10 %) of sulfuric, boric and nitric acids and the results of un-soaked and soaked were as follows.

When the soil was mixed with sulfuric acid it was observed that the strength was increased up to 8 % in both un-soaked and soaked CBR tests. When mixed with nitric acid the soil it was observed that the strength of un-soaked CBR was increased up to 6% and was decreasing thereafter. And in case of soaked CBR the results were increasing up to 8% and was decreased thereafter. When boric acid was mixed with soil found that for un-soaked CBR the results were increased up to 8% and were decreased at 10% and for soaked CBR test the maximum strength was at 6% and was decreased from 8%.

From the above results it was observed that the soil has attained its maximum strength when mixed with sulfuric acid at 8% when compared to nitric and boric acids.

Unconfined Compression Test was conducted on sulfuric acid, nitric acid and boric acid at 0-2-4-6-8-10 % and the results were as follows

When the soil was mixed with sulfuric acid at different percentages of sulfuric acid it was found that for 0 day and 3 days the strength was increased up to 8% whereas for 7 days the maximum value was reached at 6% and was decreased from thereafter. When nitric acid was mixed with black cotton soil, for 0 day, 3 days & 7 days it was found that the results were increased up to 8% and were decreased thereafter. When the soil was mixed with boric acid, for 0 day, 3 days & 7 days it was found that the results were increased up to 8% and were decreased thereafter

From the above results when compared with nitric acid and boric acid it was observed the soil has attained its maximum strength when mixed at 0 day for 6%, for 3 days the maximum strength was attained at 8% and for 7 days the maximum value was at 8% for sulfuric acid.

From all the above test results and considerations it can be observed that the soil has attained its maximum strength when it is mixed with Sulfuric Acid when compared to Nitric Acid and Boric Acid. This is because of the excess salt contents present in Sulfuric Acid which mix thoroughly with soil and absorb the stiffness content present in the soil which in turn helps in bonding between the soil particles and Sulfuric Acid which are much more needed to strengthen the soil.

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