

Effect on Index Properties of Black Cotton Soil by Alkali Content “Sodium Hydroxide” (NaOH)

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Abstract— Stabilization is a technique to improve Physico-chemical and geotechnical properties of soil so as to obtain desired characteristics of soil for any structural work, herein this research work NaOH is used as a stabilizing agent to stabilize the Black cotton soil collected from Jabalpur region. Ions Na⁺ and OH⁻ interact with silica and alumina present in soil to chemically change its properties. The main Objective of this research work is to determine the effects of NaOH on mixing with black cotton soil used as a stabilizing material. NaOH is mixed in different concentration varying from 0 to 16% with soil and properties like consistency limit, Shrinkage Limit, and Swelling percentage are observed with the increasing concentration of NaOH, It can be concluded that some properties of Soil improved and some degraded.

Key words: Sodium Hydroxide, Atterberg’s limits, Black Cotton Soil, Concentration

I. INTRODUCTION

Black cotton soil also known as expansive soil covers major portion of soil deposit in central and Deccan part of India which include Madhya Pradesh Maharashtra Orissa, Karnataka Gujarat and also parts of Andhra Pradesh and Karnataka. When exposed to change in moisture content they exhibit highly swelling and Shrinkage Characteristics Due to these properties it has been found to be most troublesome in construction purposes. To overcome these problem stabilization techniques are used which may be mechanical or chemical. This study aims at stabilization the soil chemically using NaOH as a stabilizing agent. Sodium Hydroxide is an odourless, whiteflake, non-combustible solution, it does not burn but it is highly reactive material. NaOH breaks into (Na⁺ and OH⁻) ions, which interacts with mineral of soils to exhibit change in its properties.

Stabilization is one of the methods for treating the expansive soils to make them fit for construction.

Variety of stabilizers may be divided into three groups

- Traditional stabilizers (lime, cement etc.),
- By-product stabilizers (fly ash, quarry dust, phosphor-gypsum, slag etc.)
- Non-traditional stabilizers (suffocated oils, potassium compounds, polymer, enzymes, ammonium chlorides etc.).

This study aims at stabilizing the soil chemically using NaOH stabilizing agent. Sodium hydroxide ions are odourless while non-combustible solution, it does not down but it highly reactive. It reacts with water forcefully and generating enough heat for reaction. NaOH breaks into Na⁺ and OH⁻ ions which interact with mineral of soils to exhibit change in its properties.

II. LITERATURE REVIEW

Gogo(2009) suggested that the stabilization of soil from Ghana for building and construction purposes by mixing and curing the soil with various additives. These additives have shown the best resistance to failure in dry state however NaOH has shown the best resistance to failure in wet state.

Esaifan(2013) evaluated the quality and suitability of kaolinite soils from the southern Jordan desert to use it in the future work as a raw material for built up an in-situ water harvesting system after applying the technology of inorganic polymerization techniques of using NaOH.

Graves and Smith (1988) reported the use of chemicals and emulsions as compaction aids to soils, as binders and water repellents which simultaneously modify the behaviour of soil.

Mitchell(1993) evaluated alkali at lower concentration can cause clay-alkali interaction which produces new compounds affecting the clay structure.

R. Shivshankar (2011) has found, the decrease in liquid limit with increase in the concentration of NaOH was due to the predominant influence of increase in electrolyte concentration.

A. Material Used

1) Black Cotton Soil

Sr. No.	Characteristics of Soil	Value
1	Specific gravity	1.99
2	Sand Content	3
3	Silt Content	68.58
4	Clay Content	28.42
5	Liquid Limit	64.48
6	Plastic Limit	26.25
7	Shrinkage Limit	38.23
8	Free swell Index	28.83

Table 1: Black Cotton Soil

According to Indian Standard soil is classified as high plastic clay (CH)

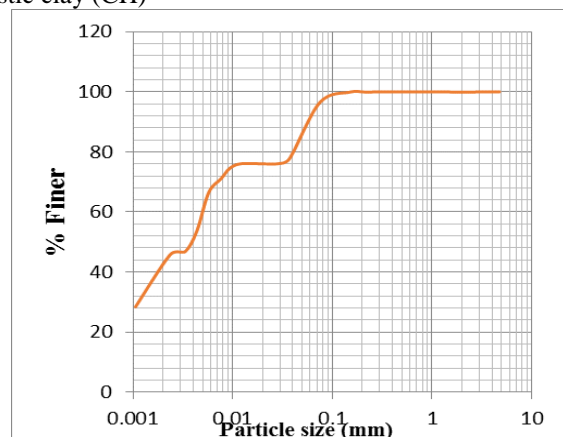


Fig 1: Particle size distribution curve of black cotton soil

B. NaOH

Sodium hydroxide in a solution is a white, odourless material. It reacts violently with water generating enough heat to ignite combustibles materials. Due to alkaline attack, sodium hydroxide can change the Properties of clay mineral and it creates strong affinity with soil minerals. It does not affect to environment but affected in like air because react festally with air moisture since the solid is deliquescent, Hence it can used to stabilized soil.

III. METHODOLOGY

The soil used for the experimental work is collected from Archha Village near Jabalpur region .The soil sample were the oven dried, pulverized and sieved through 4.75mm Sieve. NaOH is mixed with Black cotton soil at different concentrations varying from 0 to 16%. Different concentrations of NaOH mixed with water taking 50% by weight of soil are mixed together make a homogeneous mix. This mixed is then transferred to a polythene bag and a kept for 2 to 3 days, which is then dried in oven and obtained sample is used for the experimental work.

Following test are performed on these samples.

Liquid Limit Plastic Limit Shrinkage Limit, differential free swell index.

IV. RESULT AND DISCUSSION

A. Differential Free Swell Index

The effect of NaOH on soils Atterberg limits is shown through Graphs. The experimental work done By P. Hari Prasad results that soil mixed with 4N Concentration of NaOH Shows higher swelling as compare to normal water while in through this research work it is observed that soil Swells abruptly at 2% when mixed with NaOH Concentration to 68.18% & than it starts to decrease gently with further increase in concentration &finally DFS becomes 0 to 14% NaOH Concentration.

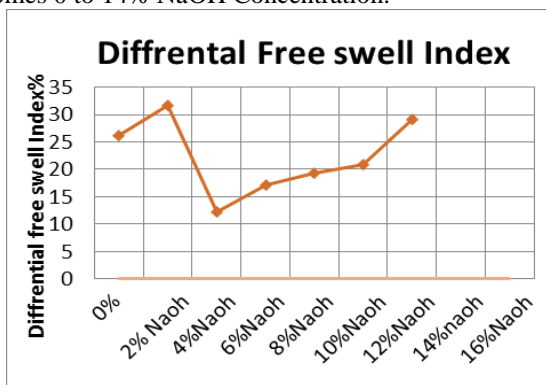


Fig. 2: Differential Free Swells Index

B. Atterberg's limits

According to Saratkumar Das soil when mixed with Alkali active fly ash Liquid limit decrease gradually & Plastic limit increase results in the reduction of plasticity index similar trend is observed in this study also when liquid limit decreases with increasing NaOH concentration however there is an initial increment in Liquid Limit at low concentration of NaOH Opposite trend is Observed in case of Plastic limit it initially reduces till 4% NaOH& increase

with further increase in NaOH as a result Plastic index reduces with increases NaOH concentration.

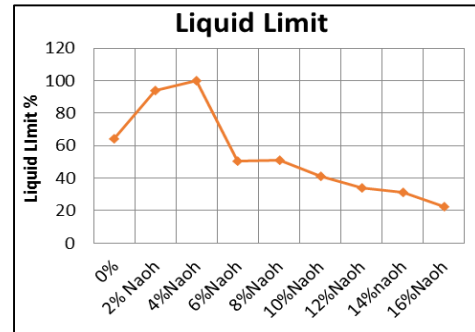


Fig. 3: Liquid Limit

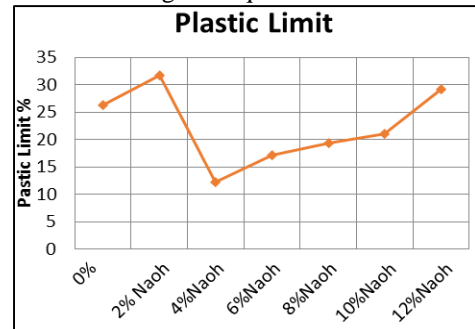


Fig 3: Plastic limit

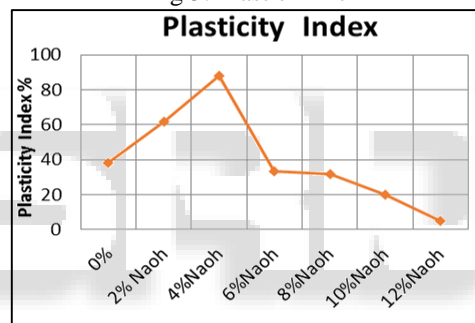


Fig. 4: Plasticity Index

C. Shrinkage Limit

Fig. shows the gradual increase in shrinkage limit when mixed with increasing concentration of NaOH. On mixing 2% NaOH shrinkage limit decreased in comparison to normal soil after increasing NaOH concentration then increasing shrinkage limit of Soil, at 16% concentration NaOH given a maximum result of shrinkage limit of soil.

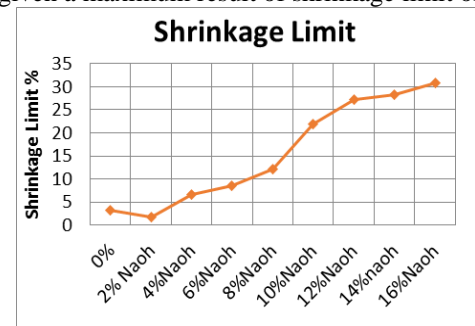


Fig. 5: Shrinkage Limit

V. CONCLUSION

Various experiment were performed to find out on black cotton soil mixed with Different NaOH concentration &

result observed are follow Index properties of Black cotton soil.

- Liquid limit of soil decreases with concentration of sodium hydroxide might be due to the predominant influence of increase in ions concentration in the soil and at 16% concentration NaOH concentration and give an excellent results.
- Plastic limit of soil varies with difference NaOH concentration, There is no definite trend of variation in the plastic limit.
- Plasticity index of soil decreased with increased in the NaOH concentration, and the maximum value of plasticity index is obtained at 12% NaOH concentration. Generally plasticity index of black cotton soil, varies on particle interaction and react with ions (Na⁺, OH⁻).
- Experimental studies suggest that Shrinkage limit of black cotton soil gradually increased from 3.2% of simple soil to 30.74% for soil containing 16% NaOH concentration.

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