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Improved Quality of Roadway in Highway Construction and Maintenance Using Soil Mechanics

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Abstract- In this research, it is proposed to stabilize the soil surrounding the water and sewerage networks with sodium chloride to avoid the formation of holes produced by leaks that cause fines dragging that weaken the soil and cause collapse, a phenomenon known as piping or internal erosion. The soil was characterized by the SUCS and AASHTO methods, carrying out the tests of sieving granulometry, sedimentation granulometry, consistency limits, and natural humidity. The compaction test was carried out by means of the modified Proctor test on the standard sample and the samples with the addition of NaCl, to obtain the maximum dry density and humidity, using them as a reference in the unconfined CBR.

Keywords- Stabilization; Piping; Permeability; Bearing capacity; Soil.

I. INTRODUCTION

Urbanization and modern advancement in India needs to focus on development procedures of highways, railways, air terminals and private structures. For these developments should require great soil conditions for establishment sand dikes. The sweeping soils are hazardous soil for development and most generally accessible in significant places in India. Particularly far reaching soils are primarily under goes swelling and shrinkage issues when dampness content changes in that soil. Because of high swelling and shrinkage issues posture huge issues to the structures. Adjustment on sweeping soil utilizing admixtures is a decent answer for the swelling and shrinkage issues. Adjustment controls the impacts on establishment and structures. Research centerwork conveyed by adding admixture to the sweeping soil at various extents for this test ponder. The shear quality of the soil has both inside grinding and union. Compaction offers quality to the soil expanding the heap bearing limit and soil ends up noticeably steady. Artificially adjusted the soil by including lime, cement, flyash and lime mixes were utilized adequately. Research center test was directed for street development with previously mentioned concrete mixes properties. The point of this paper, depends on our Indian economy and budgetary status we have to give the development strategy too. Road construction method through geo-technology schedule with precautions: 1. Road construction/maintenance with the analysis of soil type and causes of the damage using with BC soil, fly ash and Lime concrete. 2. To increase the life time and strengthening of the road construction based on different BC soil land. 3. BC soil based concrete mix for support BC soil land and other soil lands.

II. MOTIVATION

Mainly in economically backward countries, the economies lead by the construction field for the development of the country, and it also depends on the durability aspect of construction. In this regard, one step for strengthening the rural economy is based on by providing all weather resistant roads have been emphasized. In countries like India, the biggest handicap is to provide a complete network

of road system with the limited finances available to build the road by conventional methods. Therefore there is a need to resort one of the suitable methods of low cost road construction. The construction cost can be considerably decreased by local materials including local soils for the construction of the lower layers of the pavement such as the sub-base course. The layers of the pavement may comprise of different types of soils. One of them is black cotton soil and it is highly weak because of the large changes in volume due to fluctuations in the moisture content. In monsoon seasons, water which is absorbed by soil results in swelling, and also in the reduction of bearing capacity. In dry seasons, these soils shrink or reduce in volume due to evaporation of water and they become harder. For effective treatment of soil, one of the methods is by adding the quantity of Sodium chloride to develop increased strength varies with the type of clay mineral present. Regarding the strength of clay soils, air drying in a humid environment produces a hard and strong mass. In the extreme, banking at elevated temperatures converts clay to brick. For most practical purposes the strength of soil has less importance than its resistance to deformation under load. Not all low strengths are associated with increased moisture content. In India Black Cotton soil also known as "Regurs" are found in extensive regions of Deccan Trap. They have variable thickness and are underlain by sticky material locally known as "Kali Mitti". In terms of geotechnical engineering, the Black Cotton soil is one which was associated as engineering structure and in presence of water it will show a tendency to swell or shrink causing the structure to experience moments which are largely unrelated to the direct effect of loading by the structure. The black cotton soil is not suitable for the construction work on account of its volumetric changes. It swells and shrinks excessively with a change of water content. Such tendency of soil is due to the presence of fine clay particles which swell when they come in contact with water and also resulting in alternate swelling and shrinking of soil due to which differential settlement of structure takes place. To change or modify the soil properties by some means to suit the requirements is known as "stabilization". Stabilization in a broad sense incorporates the various methods employed for modifying the properties of a soil to improve its engineering performance. The main objective is to increase the strength or stability of soil and to reduce the cost by making the best use of the locally available materials.

The chief properties of a soil with which the construction engineer is concerned are volume, stability, strength, permeability, and durability. Stabilization is not only in terms of corrective treatment but also as a preventive measure against adverse conditions. The stabilization converts the soil to a rigid mass to resist the internal swelling pressure of clays and retards moisture movement within the soil. For example for blocking pores to improve soil strength and also volume stability, stabilization is necessary. Mechanical properties of a soil can readily be improved or maintained at some constant design condition by stabilization. Problems of soil permeability can generally be corrected by stabilization. The problem of poor durability of soil can be avoided. Out of the many methods of stabilization techniques, sodium chloride stabilization suits best to the black cotton soil. Sodium chloride stabilization is achieved with calcium hydroxide. The soils to be stabilized are first mixed with, predetermined sodium chloride at which the maximum strength occurs. Thus the corresponding optimum water content is also added and compacted to the maximum dry density. However, the performances of these compacted soils are inadequate for the traffic conditions.

Keeping in view, the variation pattern of the dry density with water content both for pure soils and soils-sodium chloride mixes, it may be thought that the OMC (Optimum Moisture Content) for MDD (Maximum Dry Density) may not be OMC for strength parameters. So the stabilization has done for the black cotton soil which was done in this project work by using sodium chloride as an admixture. If the requirements of these soils are not sufficient, then either the soils are to be totally replaced by a better one or modify the properties as required. The former process is very costly and generally, the latter is preferred. This project deals with studying such variation of strength parameter

CBR with water content, of a sodium chloride stabilized soil. A locally available soil is selected for this purpose. The OMC of the soil sodium chloride mixes at different percentages of sodium chloride are determined. The soil with sodium chloride content is mixed with corresponding OMC and MDD and its strength parameters are noted.

The optimum sodium chloride content at which maximum strength occurs is noted as sodium chloride Modified optimum, (for CBR). It is assumed that the Ratio of strength at OMC & corresponding MDD and respective maximum strength for any sodium chloride content remains constant. Also, it is assumed that the variation between maximum strength at any sodium chloride content and the strength at OMC & corresponding MDD is a straight line. The sodium chloride is added to the soil at different proportions and the variation of strength parameters (CBR) is noted. The experiments are done for two compactive efforts vis. Standard proctor compactive effort and Modified proctor compactive effort. The stabilization is done for the following reasons. Soil stabilization is widely used in connection with road, pavement and foundation construction. It improves the engineering properties of the soil,

- **Strength -** to increase the strength and bearing capacity
- **Volume Stability -** to control the swell-shrink characteristics caused by moisture changes
- **Durability -** to increase the resistance to erosion, weathering or traffic loading.
- To reduce the pavement thickness as well as cost.

Objective

- To modify the engineering properties of the soil,
- To improve the stiffness and the tensile strength of the soil,
- To decrease the pavement thickness,
- Improve durability and the resistance to the effect of the water,
- Life of landfill is extended and natural resource is extended.

Scope of Our Project

- The scope of the study is used for finding the best pair of chemical to use it in the stabilisation method by strength characteristics and compression characteristics.
- The soil stabilisation will increase the soil properties.

III. PROPOSED METHODOLOGY

Sodium chloride (NaCl) based soil stabilization is a method used to enhance the engineering properties of soils, primarily to improve their load-bearing capacity, reduce their plasticity, and control dust.

This technique is particularly useful in road construction, airstrips, and other infrastructure projects where stable soil conditions are critical. Here are some key points about sodium chloride-based soil stabilization:

Mechanism

Water Retention

Sodium chloride helps retain moisture in the soil, which can be beneficial in arid regions by reducing the evaporation rate. This helps maintain the soil's compactness and reduces the risk of dust formation.

Clay Flocculation

Sodium ions can replace other cations in the soil, such as calcium and magnesium, leading to the flocculation (clumping together) of clay particles. This process reduces the soil's plasticity and improves its stability.

Crystallization

When sodium chloride is added to the soil and comes into contact with moisture, it dissolves and subsequently crystallizes. This crystallization process can bind soil particles together, increasing the soil’s strength and load-bearing capacity.

Applications

Road Construction: Sodium chloride is often used in the construction of unpaved roads to stabilize the

soil and reduce dust. It helps create a more solid road surface that can withstand traffic loads.

Airstrips and Runways
In remote areas, especially military or temporary airstrips, sodium chloride can be used to stabilize the soil, making it suitable for aircraft operations.

Erosion Control
The moisture-retaining properties of sodium chloride can help control soil erosion by keeping the soil compact and reducing the likelihood of it being washed away by rain.

Advantages
Cost-Effective: Sodium chloride is relatively inexpensive compared to other chemical stabilizers.
Easy Application: It can be easily applied using standard equipment such as spreaders and mixed into the soil using graders and compactors.

Immediate Results
The stabilization effects are often noticeable shortly after application.

Disadvantages
Corrosion: Sodium chloride can be corrosive to metal structures, vehicles, and equipment used in the stabilized area.

Environmental Concerns
Excessive use of sodium chloride can lead to soil and water salinization, which can adversely affect plant growth and groundwater quality.

Temporary Effectiveness
The stabilization effect may diminish over time, especially in areas with high rainfall, requiring periodic reapplication.

Application Process
Site Preparation: The area to be stabilized is cleared of vegetation and debris.

Application of Sodium Chloride
Sodium chloride is spread evenly over the soil surface at the recommended rate.

Mixing
The sodium chloride is mixed thoroughly with the soil using mechanical equipment such as graders or rototillers.

Compaction
The soil is then compacted to the desired density using rollers or other compaction equipment.

Moisture Control
Adequate moisture must be maintained during the process to ensure proper interaction between sodium chloride and soil particles.

Best Practices
Proper Dosage: Use the correct amount of sodium chloride as recommended based on soil type and project requirements to avoid environmental issues.
Monitoring: Regularly monitor the stabilized soil for signs of degradation or environmental impact.

Supplementary Measures
In some cases, it may be beneficial to use sodium chloride in combination with other stabilization methods or materials to enhance effectiveness and longevity.

Sodium chloride-based soil stabilization can be a useful tool in certain applications, but it requires careful consideration of the environmental impact and the specific needs of the project.

IV. RESULT AND SIMULATION

California Bearing Ratio Test
Sample taken 10 kg.
Wt. of mould =17.35 kg,
Division = 0.002 mm 2.73 kg
Proving ring least count =0.002 mm
Deformation dial gauge =0.01 mm

CBR at 2.5mm penetration -Load for 2.5mm penetration/standard load X 100 CBR at 5.0mm penetration =Load for 5.0mm penetration/standard load X100.

CBR Observation Data Sheet.

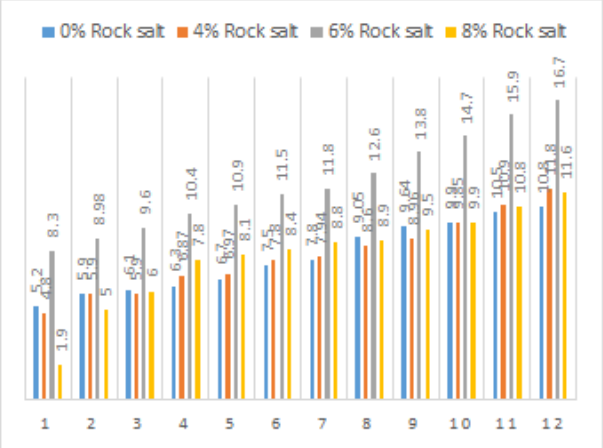

Fig.1: CBR test.

Hypothesis

H01: There is no significant possibility of some kind of time increasing Quality of roadway in highway construction and maintenance using Rock salt And Penetration (mm) parameter are evaluating.

H1: There is significant possibility of some kind of time increasing Quality of roadway in highway construction and maintenance using Rock salt And Penetration (mm) parameter are evaluating.

Table 1: Penetration (mm) And 6% Rock salt.

Penetration (mm)	6% Rock salt
0.5	8.3
1	8.98
1.5	9.6
2	10.4
2.5	10.9
3	11.5
3.5	11.8
4	12.6
4.5	13.8
5	14.7
5.5	15.9
6	16.7

Table 2: F-Test Two-Sample for Variances

F-Test Two-Sample for Variances		
	Penetration (mm)	6% Rock salt
Mean	3.25	12.09833
Variance	3.25	7.336761
Observations	12	12
df	11	11
F	0.442975	
P(F<=f) one-tail	0.096321	
F Critical one-tail	0.35487	

Test statistics Result:

In this F- Test F > Fcritical, hence Null hypothesis reject, and the alternate hypothesis is accepted.

Interpretation and Discussion

It is seen that there is significant possibility of some kind of time increasing Quality of roadway in highway construction and maintenance using Rock salt And Penetration (mm) parameter are evaluating.

V. CONCLUSION

The collapse of soils is a very complex phenomenon involving a large number of intrinsic and environmental parameters. It is mainly due to the rearrangement of the soil particles after flooding. The main observations of this study are:

- The collapse potential is reduced with increase of initial water content and increase of energy of compaction;
- The treatment by salt (NaCl) reduced the collapse potential and subsequently the damage associated with it to structures;

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