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Analysis of Lime and Sodium Chloride's Effects on Large-Scale Soil

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Abstract

Soils with a high capacity for expansion in response to an increase in moisture content. Montmorillonite, a kind of clay, is mostly to blame for the soil's expansive nature. Swelling soils, often known as black cotton soils, are another name for expansive soils. Expansive soils cover the majority of central India and a sizable portion of southern India. Another issue with expansive soils is that as the soil becomes more saturated, its strength reduces. If the right precautions aren't taken, buildings, roads, runways, pipelines, and other facilities constructed on such soils might suffer significant damage. The dry weight of soil is used to determine the percentage of lime to add to the mixture, which might range from 2% to 6%. Soil mixes with different proportions of lime and sodium chloride (2%, 3%, 4%, 5%, and 6% of lime added per dry weight of soil) may be made. The liquid limit, plastic limit, plasticity index, and flow index of the soil were all shown to decrease when lime was added to the mix. Unconfined compressive strength, dry density, and oxidation-reduction potential all rise when lime content changes. The aforementioned characteristics improve with the addition of Lime and Nacl, as opposed to Lime alone.

I. INTRODUCTION

After stones like basalt and trap undergo compound degradation, the resulting soil is called sweeping soil, and it is often found where the stones were originally arranged. Due to a fairly deep water table, the soils there are often dry. They get soaked during the rainy season. As the moisture level rises, the muds spread. The soil mass may undergo dramatic changes. Damage and failure of structures built on such soils due to differential hurl is possible.

Extensive soils cover the majority of central India and a small portion of southern India. Although these soils are ideal for growing cotton, they should not be used in building reinforcements. Heavy damage to buildings, roads, and bridges is possible.

runways, pipelines, and other structures built on such soils are at risk if the necessary precautions are not taken. Generally, the effects may be avoided if the properties of wide soil are properly investigated and acceptable steps are taken in the planning, development, and support of designs based on broad soils.

Extending the amount of water in the distant soil causes it to flourish. When the water content of a substance drops, therapists and rest periods emerge. These cracks might go quite far underground. The

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maximum size of the shrinkage cracks is typically capped at 20 mm.The dynamic zone is the depth of the expansive soil where fluctuating moisture content causes expansion and contraction.

OBJECTIVES OF THE STUDY

The main objective of present research is to investigate the effect of lime and NaCl on swell, compaction and mechanical behaviour of expansive soil.

Testing of untreated soil to know the physical and designing properties.

Examination of the impact of lime on sweeping soil by adding various rates of lime to thedirt alone and by performing geotechnical tests on treated soils.

Examination of the impact of lime and NaCl on sweeping soil by adding various rates of limeand various rates of NaCl of lime to the dirt and by performing geotechnical tests on treated soils.Examination of test consequences of untreated and lime treated and lime and Sodium chloride treated broad soil.

II. LITERATURE REVIEW

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In fine grain soils, ionic exchange is the third process that occurs fast when water is present. As the concentration of calcium ions increases around clay particles as a consequence of hydration of lime, the existing low electro - negative ions are replaced by calcium ions, resulting in a thinner double layer and a narrower gap between clay minerals. As a result, enhanced gravitational forces between minerals lead to a form of flocculation or lumping together of particles (Jagannath et al, 2004). The addition of water and lime to soil quickly decreases its fluidity and swelling while significantly increasing its competence and strength. In addition, the texture of clayey soils is altered due to the tendency of clay particles to pair with one another and create larger grains (**Puppala et al, 2004**).

• The pozzolanic reaction, in which water, silicates, and aluminates form sticky gels with more carrying capacity than natural soil, is the fourth reaction. Some fine-grained soils, especially those rich in clay minerals, have a natural propensity to be pozzolanic and, when combined with lime, can form sticky gels. Pozzolanic reactions, on the other hand, are carried out gradually as opposed to abruptly like ionic exchanges reactions (**Azarfar and abdi,2003**).

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III MATERIALS

The main materials used in the present study were expansive soil, lime and sodium chloride. Experimental methodology performed for geotechnical characterization of these materialsand Soil-Lime and Soil – Lime – Sodium chloride composites.

Expansive Soil

The expansive soil is collected from Kurnool which is in Andhra Pradesh.

LIME

In this project, the lime used has following physical properties

SODIUM CHLORIDE

METHODS

In the present study the supporting experiments were carried out as per Indian standard code of practice. Experimental methodology for study of effectiveness of LIME and SODIUM CHLORIDE as a stabilizer in expansive soil

Models used for curing

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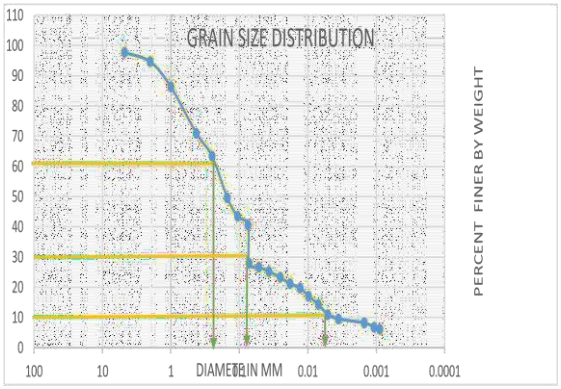
IV RESULTS AND DISCUSSIONS



GSD Curve

Variation of liquid limit and plastic limit with variation of lime

DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
soil sample	34.5	18.03	16.47
soil + 2% lime	34	19.2	14.8
soil + 3% lime	33.1	20.1	13
soil + 4% lime	31.5	20.9	10.6
soil + 5% lime	29.8	21.8	8
soil + 6% lime	31	22.9	8.1

Variation of liquid limit and plastic limit with variation of lime and NaCl

DECRIPTION	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)
soil sample	34.5	18.03	16.47
soil + 2% lime + 2% Nacl of lime	33.25	16.56	16.69
soil + 3% lime + 3% Nacl of lime	31	15.64	15.36
soil + 4% lime + 4% Nacl of lime	28.5	14.73	13.77
soil + 5% lime + 5% Nacl of lime	27.86	14.32	13.54

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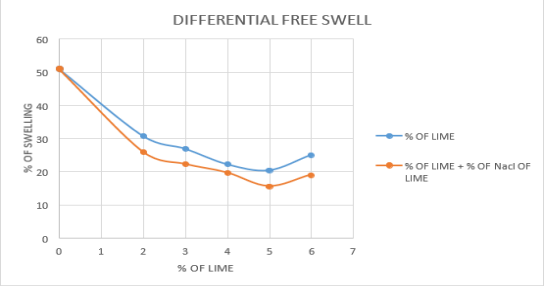
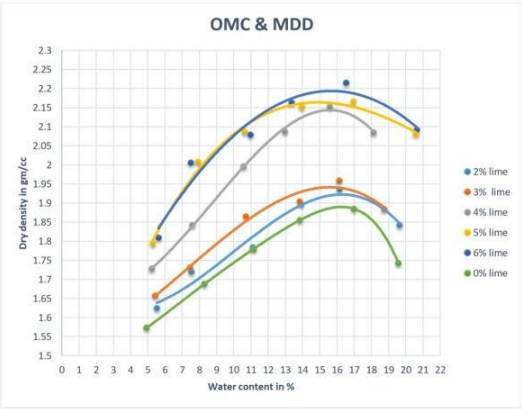
soil + 6% lime + 6% Nacl of lime	26.4	14.12	12.28



Variation of DFS with variation of lime and NaCl

Variation of OMC and MDD with variation of Lime

DESCRIPTION	MDD in gm/cc	OMC in %
Soil	1.88	17
Soil + 2% lime	1.92	16.5
Soil + 3% lime	1.94	16.2
Soil + 4% lime	2.14	15.5
Soil + 5% lime	2.17	15
Soil + 6% lime	2.19	15.2



Graphs of OMC and MDD with variation of Lime

Variation of OMC and MDD with variation of Lime and NaCl

DESCRIPTION	MDD in gm/cc	OMC in %
Soil	1.88	17
Soil + 2% lime + 2% NaCl of lime	2.11	16.2
Soil + 3% lime + 3% NaCl of lime	2.19	15.7

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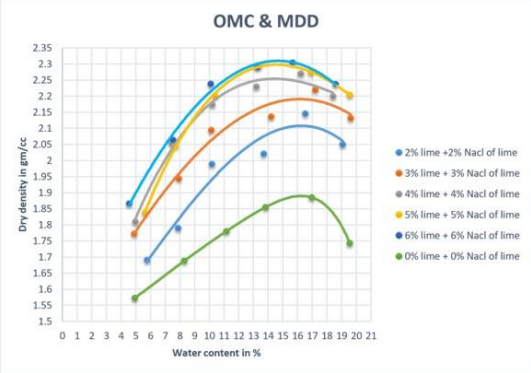
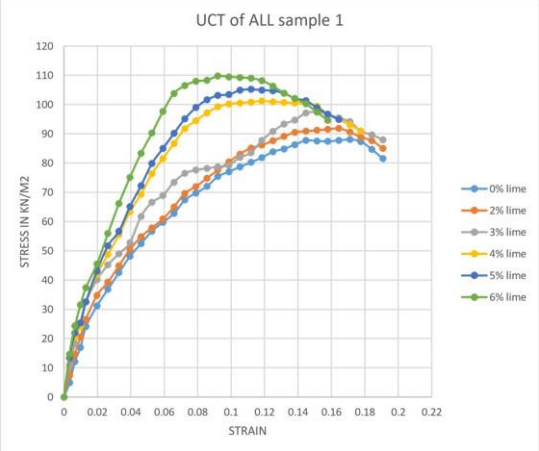
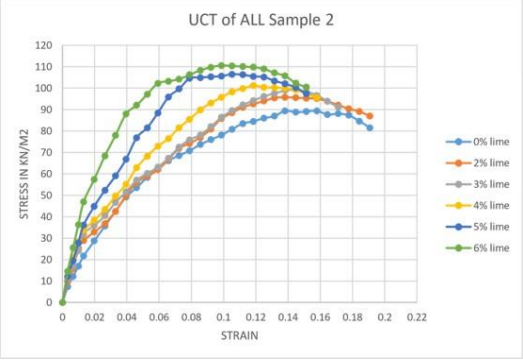
Soil + 4% lime + 4% NaCl of lime	2.26	14.8
Soil + 5% lime + 5% NaCl of lime	2.3	14.5
Soil + 6% lime + 6% NaCl of lime	2.32	14.2



Graphs of OMC and MDD with variation of Lime and NaCl



UCS of all sample 1 with variation of lime



UCS of all sample 2 with variation of lime

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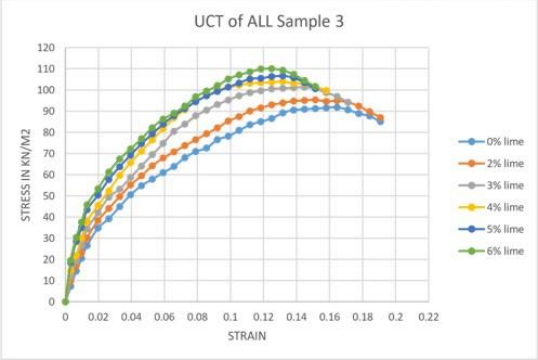
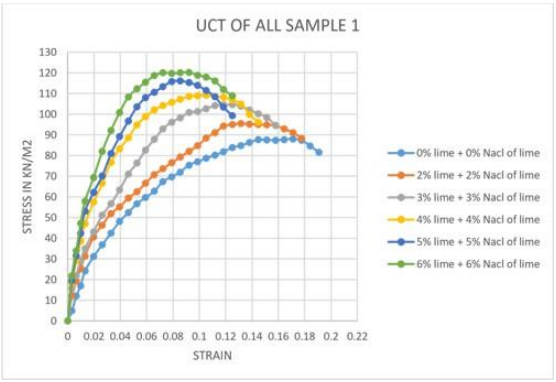


UCS of all sample 3 with variation of lime

UCS values of all samples with variation of lime

DESCRIPTION	AVG UCS in KN/m2	AVG FAILURE STRAIN in %	CONSISTENCY
Soil	89.8	16.22	Medium
soil + 2% lime	94.75	15.32	Medium
soil + 3% lime	99.31	14.03	Medium
soil + 4% lime	102.84	11.84	Stiff
soil + 5% lime	106.10	10.96	Stiff
soil + 6% lime	110.14	9.86	Stiff



UCS of all sample 1 with variation of lime and NaCl

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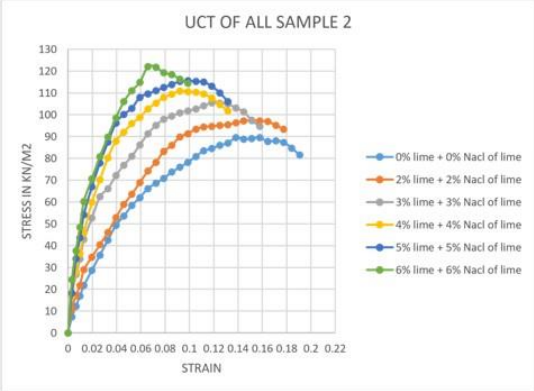
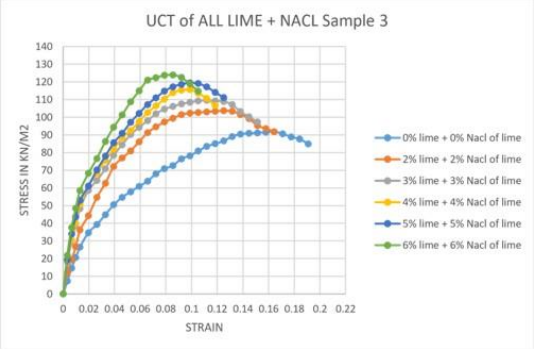


UCS of all sample 2 with variation of lime and NaCl



UCS of all sample 3 with variation of lime and NaCl

UCS of all samples with variation of lime and NaCl

DESCRIPTION	**AVG UCS in KN/m2**	**AVG FAILURE STRAIN in %**	**CONSISTENCY**
Soil sample	89.8	16.22	Moderate
soil + 2% lime + 2% NaCl of lime	98.8	12.93	Moderate
soil + 3% lime + 3% NaCl of lime	106.5	11.84	Stiff
soil + 4% lime + 4% NaCl of lime	111.9	9.42	Stiff
soil + 5% lime + 5% NaCl of lime	117.04	8.11	Stiff
soil + 6% lime + 6% NaCl of lime	122.03	7.01	Stiff

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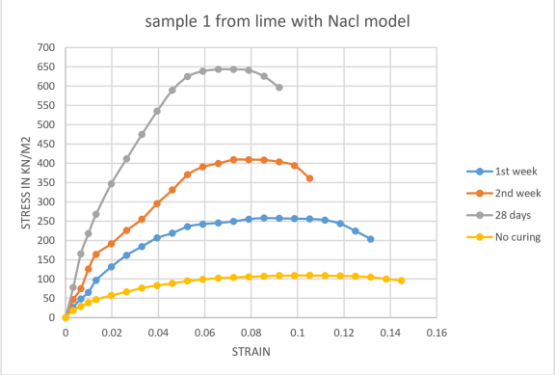
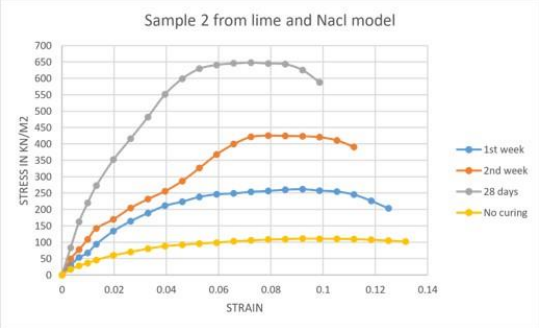
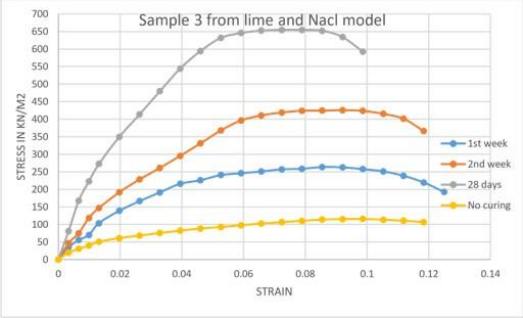


UCS of all sample 1 from lime and NaCl model with variation of curing period



UCS of all sample 2 from lime and NaCl model with variation of curing period



UCS of all sample 3 from lime and NaCl model with variation of curing period

Variation of SDI values from Lime with NaCl model

DESCRIPTION	LIME WITH NaCl UCS in KN/m2	SDI
No curing	111.9	0
1st week	261.06	1.33
2nd week	425.38	2.8
28 days	648.73	4.8

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Variation of SDI values from Lime model

DESCRIPTION	LIME MODEL UCS in KN/m2	SDI
No curing	105.83	0
1st week	254.24	1.402
2nd week	420.11	2.96
28 days	644.16	5

V. CONCLUSIONS

Based on the studies the following conclusions can be made.

- DFS of expansive soil is changed from 51% to 20% by adding 5% lime to the soil sample. That means it changes from very high to moderate state of expansiveness. And again increasing the lime content, DFS value is increases from 20% to 25% this is because of free lime present in soil.
- DFS of expansive soil is changed from 51% to 16% by adding 5% lime and 5% NaCl of lime to the soil sample. That means it changes from very state to low state of expansiveness.
- Plasticity index of expansive soil is changes from 16.47% to 8.1% by adding 6%lime. That means soil is changes from medium plasticity to low plasticity. In this liquid limit of soil is decreases and plastic limit increase.
- Plasticity index of expansive soil is changes from 16.47% to 12.28% by adding 6% lime and 6% NaCl of lime to the soil sample.
- For the same compactive effort, the MDD value is increases with the decrease in OMC by increasing lime content. Lime fills the voids present in soil and by increases the density of soil. MDD value is increases from 1.88 gm/cc to 2.19 gm/cc and OMC decreases from 17% to 15.2%. And by adding lime with sodium chloride to soil, MDD value is increases more than lime alone, with the decrease in OMC.
- Significant improvement in unconfined compressive strength is observed from the composite soil samples of lime and soil. By adding 6% lime the value of UCS is changesfrom 89.8 KN/m2 to 110.14 KN/m2. That means soil changes from medium consistency to stiff consistency.
- And also by adding sodium chloride with lime to the soil the UCS value is increases more than lime alone. The UCS value changes from 89.8 KN/m2 to 122.8 KN/m2. That means soil again changes from medium consistency state to stiff consistency state.
- After the completion of laboratory tests suitable percentages of lime and lime with sodium chloride is selected, and model is made for curing upto 28 days. At 1st week

soil sample collected, the UCS value of lime model at first week is increase from 105.83 KN/m2 to 254.24 KN/m2, at 2nd week UCS is increases from 105.83 KN/m2 to 420.11 KN/m2, at 28days value is around 644.16 KN/m2. That means, if curing period increases UCS value also increases.

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➢ Soil sample is collected from lime with sodium chloride model, the UCS values are increases from 111.9 KN/m2 to 261.06 KN/m2, 425.38 KN/m2, 648.73 KN/m2 at 1st week, 2nd week and 28 days respectively.

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