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Effects of Lime on Visakhapatnam Port Soil

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ABSTRACT : - Stabilization of soil is a process by which the soil properties can be modified. Soft soils, when contact with water loses their strength because of its high swelling potential which may lead to differential settlements and this type of soil is be found In Visakhapatnam port area. As water is the main con and it cannot be eliminated but its content can be reduced by various methods, soil was treated with lime to observe its behavior apart from reducing the content of the water using the codal provisions. For this, it was assumed that 3, 6, 9, 12 & 15 percentages of lime by weight of the soil might yield better results by improving the engineering properties of the soil. The results showed that with an increase in the content of the lime, moisture content present in the soil was reduced. In this process, it was observed that the values of Unconfined Compressive Strength, California Bearing Ratio was improving on a fairly basis up to a point and there was no improvement further in the case of UCS. It was concluded that using lime was helpful in improving the soil properties.
KEYWORDS: - stabilization, lime, port soil, UCS,CBR.

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I INTRODUCTION

Soil is the base of any structure, which supports it from beneath and distributes the load effectively. Port soils are extremely expansive in nature which causes differential settlements even if there is minimal contact with water. As it is known that Visakhapatnam port is an extension of a naturally formed harbor so for most of the duration the soil will be in damp conditions and due to this behavior, the soil around the port are also likely to undergo differential settlements which later may lead to a catastrophic failure. Since the soil strata needed for construction should not be susceptible to high settlements and must possess high shear and compressive strengths and it is highly impossible to find such strata Soil improvement is one of the techniques that can be used to stabilize the soil.

Port soils have low bearing capacity and are likely to swell more than rest of the soils when it is in contact with water and because of this problem of the soil, the soil is stabilized using different additives. This type of soil is highly unstable and can create major issues. Many researchers used lime as an additive to solve the problem for this soil. (Harish 2017, Nadgouda & Hegde (December, 2010), Zarei et al. (March, 2014) and Sujit et al. (June, 2014) .Lime can be used as a reinforcement to enhance the properties of the port soil as it increases its compressive strength (Zarei et al. (March, 2014) and Sujit et al. (June, 2014).The main objective of this research is to stabilize the soil using lime in different percentages (3%, 6%, 9%, 12%, 15%) by reducing its swell potential and increasing its bearing capacity.

II MATERIALS

1. Quick lime

Lime is one of the most important and largely used building materials. In fact, it used as the main cementing material before the advent of Portland cement. Egyptians and Romans made remarkable application of this material for various constructional purposes.

Quicklime contributes high plasticity and workability to mortar. Addition of Portland cement decreases the time of hardening of the mortar and imparts strength to it. The high calcium or fat limes are generally more plastic than dolomite Quicklime, but both impart high plasticity to mortar. When clay is added to limestones in proportions varying from 10 to 30 percent, to produce lime, such limes are called hydraulic lime. Such limes start setting and hardening on combining with water or under water, hence they are called hydraulic lime.

Apart from the above properties there are few interesting facts associated with lime. Whenever lime comes in contact with water a hydration reaction takes place between the calcium compounds and the water molecules resulting in the formation of calcium hydroxides by consuming the water. This basic concept has

attracted us to start working with Visakhapatnam port soil as it is in damp conditions most of the times, water can be made reacted with lime by adding that to it and ultimately water content can be reduced and the final compounds formed also holds the soil particles together thus improving its engineering properties.

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Soft soil is non-homogeneous and its properties are highly variable and complex. The distribution of the soft soil ranges from fibrous to amorphous and consists of peat, clay and silt. These type of soils are highly unstable .
capacity and high swelling potential. They have considerable strength in dry condition but as their moisture content reaches to saturated level, a notable decrease in the strength can be observed.

Property	**Value**
Specific gravity	2.797
Free Swell Index (%)	100
Optimum Moisture Content (%)	22.42
Maximum Dry Density (g/cc)	1.318
Unconfined Compressive Strength (kg/cm^2)	1.462
CBR (unsoaked) %	3.93

Table No.1 .Soil Properties

III METHODOLOGY

The following table 2 represents the methodology of laboratory testing programme.3%, 6%, 9%, 12%, 15% of lime by the weight of soil for free swell index, standard proctor test, LL, PL, UCS tests and 3%,6% of lime by weight for CBR test is used. All the tests were conducted in accordance with IS-2720 codal practices.

Experiments	**Lime content (% by wt.)**
Free swell index	3,6,9,12,15
SPT	3,6,9,12,15
UCS	3,6,9,12,15
CBR	3,6

Table No.2 Lime Proportions for Various Tests

IV RESULTS & DISCUSIONS

Free Swell Index [IS: 2720 Part 40-1977]:

As per the codal procedures and with the assumed lime content the free swell index was determined and found to be as following

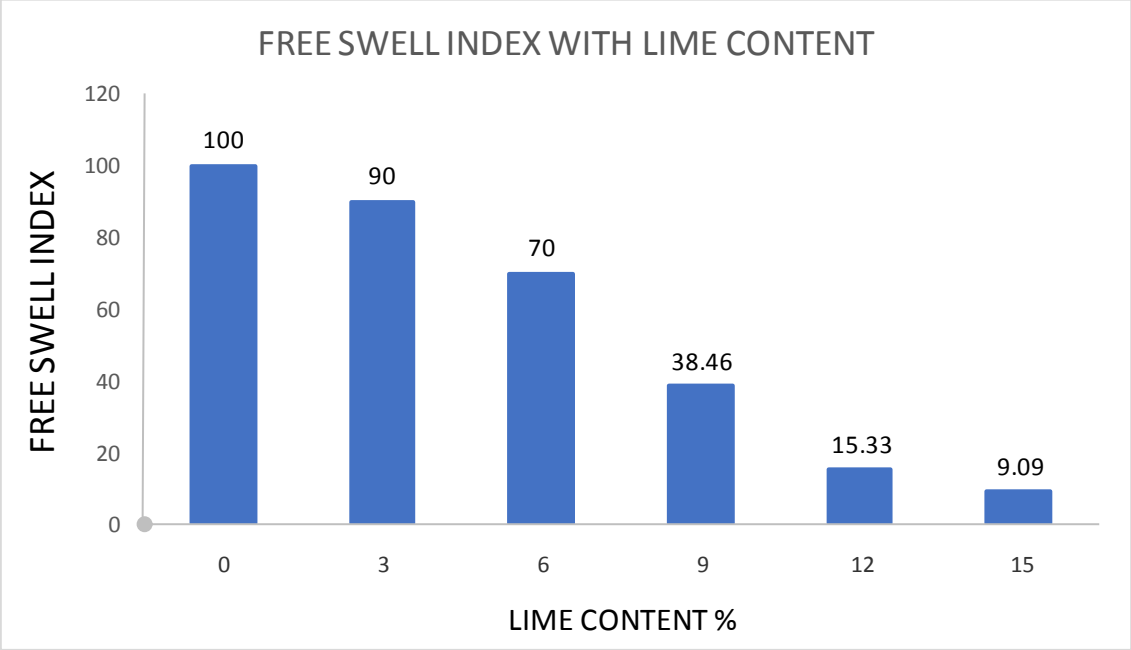

Figure.1. Free Swell Index Variation with Lime Content

The effect of lime on Free swells index of Visakhapatnam port soil is extremely good and the potential for selling is reduced drastically with addition of lime. And the Free swell index value is reduced from 100% to 38.46% with addition of lime of 9%.

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As per the codal procedures and with the pre-assumed lime contents the OMC & MDD were determined after adequate reaction time and found to be as following

SPT values	**Lime Content %**					
	0	3	6	9	12	15
MDD g/cc	1.318	1.34	1.369	1.405	1.3713	1.362
OMC %	22.42	24.6	27.9	30.01	31.21	32.9

Table.3. SPT values with varying content % lime

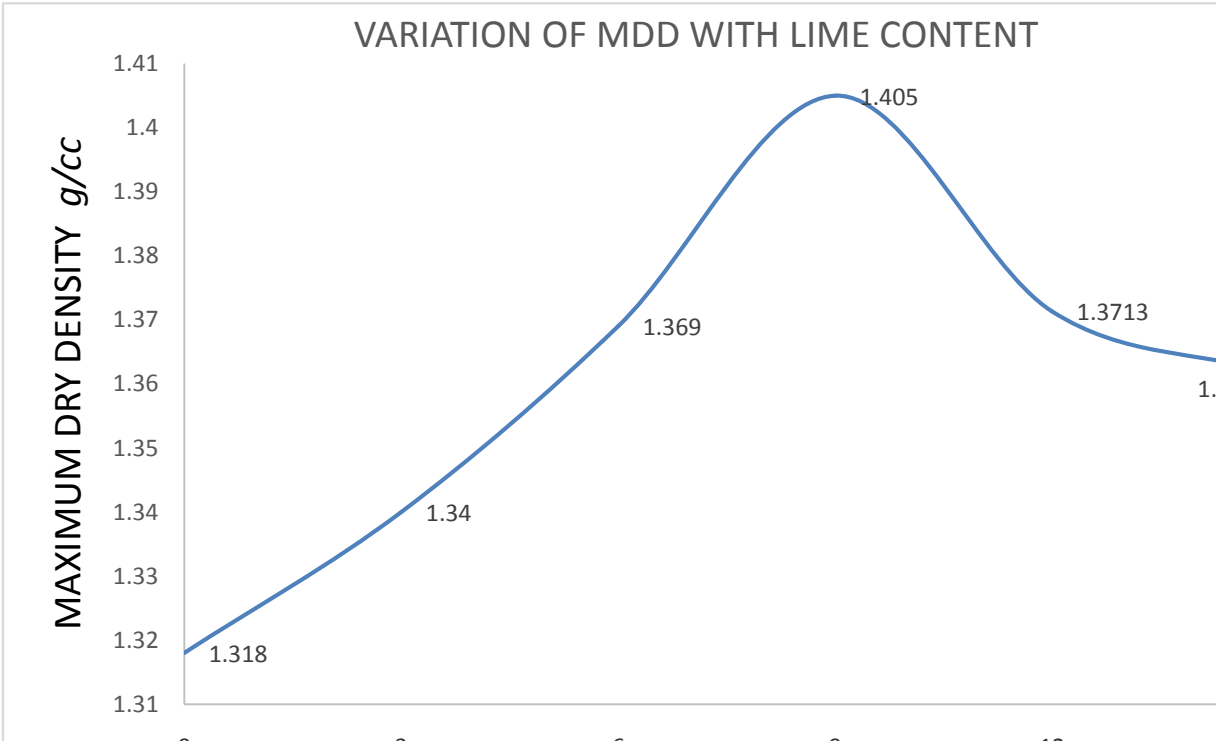

Figure.2. MDD Variation with Lime Content.

From the table.3, and graph 2, it has been observed that MDD value is increased from 1.318g/cc to 1.405g/cc for lime content of 9% and later with increasing of lime content the effectiveness of lime is reduced and MDD value is decreased to 13.62g/cc for lime content of 15%.

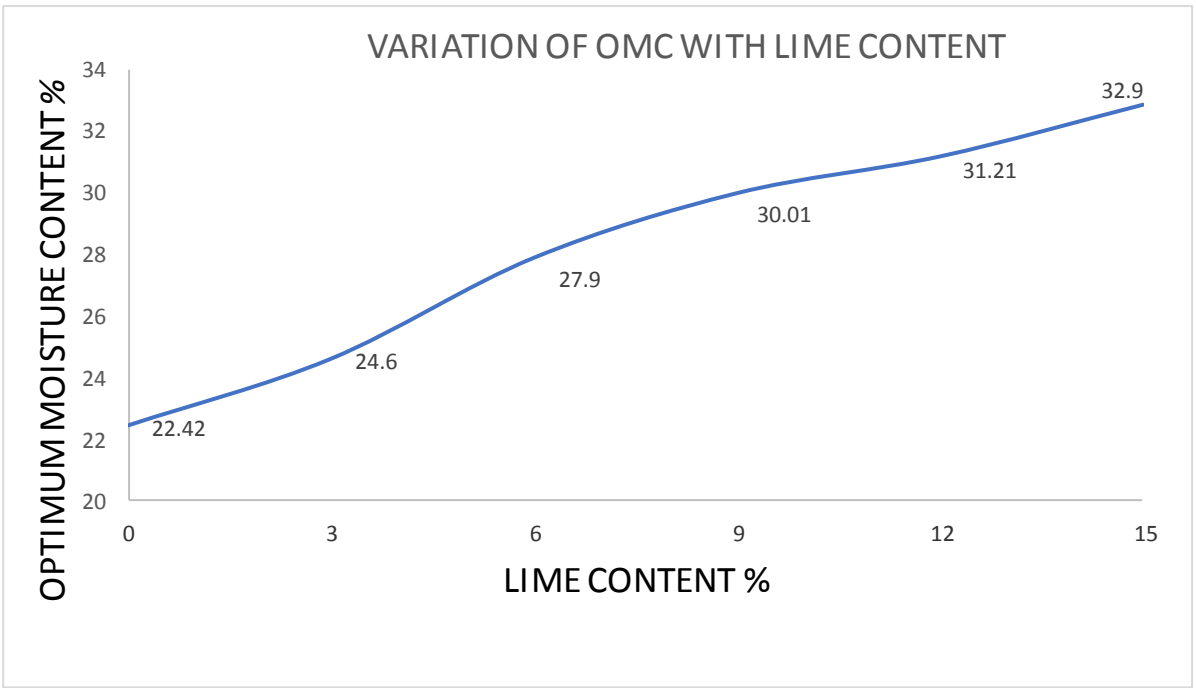

Figure.3. Variation of OMC with % Lime Content

From figure3, it is observed that the OMC is increased with increasing proportion of lime content. The reason for increasing OMC is, lime took some water content to made a reaction with water and finally that reaction would be helpful to enhance the soil properties.

Unconfined Compression Test [IS 2720 (Part 10): 1991]:

As per the codal procedures and with the pre-assumed lime contents the UCS specimens are prepared, tested and few engineering properties were determined and found to be as following

Stress Kg/cm^2	**Lime Content %**					
	0	3	6	9	12	15
Axial	1.462	10.3	16.11	18.789	14.82	11.821
Shear	0.731	5.15	8.055	9.394	7.41	5.9105

Table .4. UCS values with Lime content.

The table 4.shows the variation of UCS values with %lime content and it is observed that both axial stress and shear stress increases with increasing value of lime content.

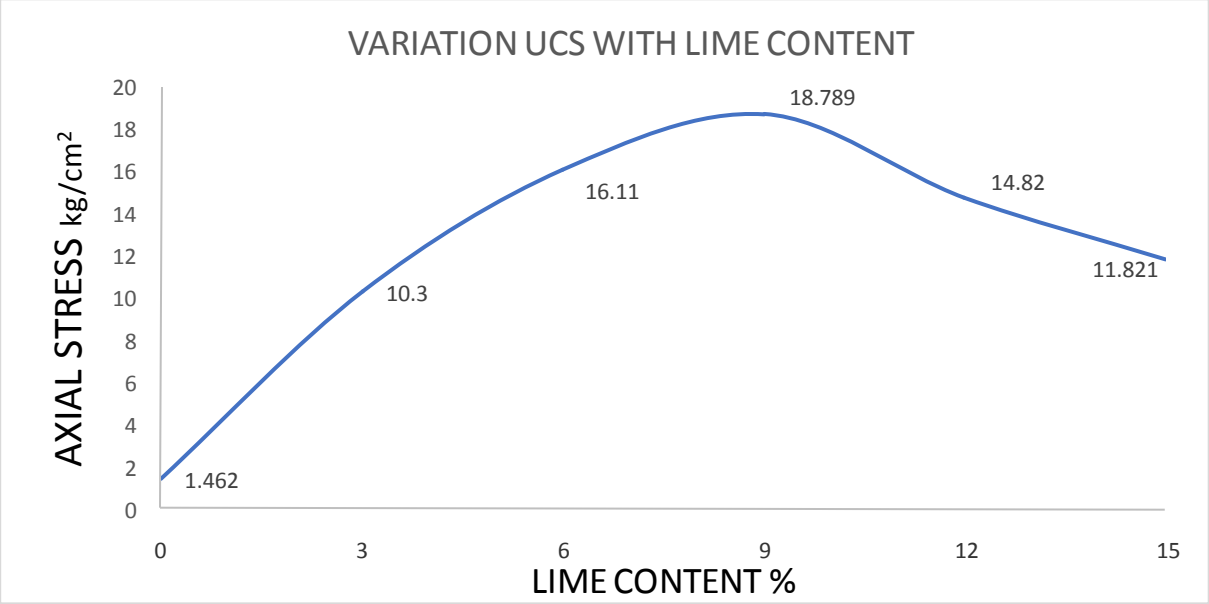

Figure.4. Axial Stress Variation with Lime Content.

From the figure 4, it is observed that for 9%lime content it gives maximum value and the value is increased from 1.462kg/cm^2 to 18.789kg/cm^2.

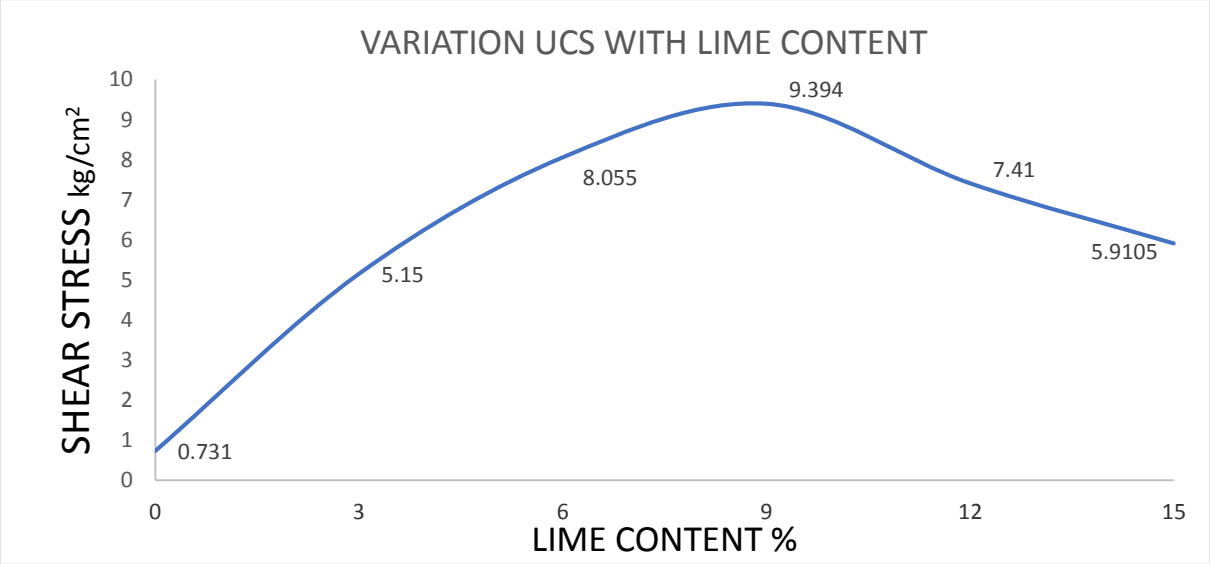

Figure. 5. Shear Stress Variation with Lime Content

From the figure 5, it is observed that shear stress also increased with increasing value of lime content and maximum value observed at optimum content of 9%.

California Bearing Ratio (CBR) Test [IS 2720 (Part 16) 1987]:

As per the codal procedures and with the pre-assumed lime contents the CBR test specimens were prepared and tested for un soaked conditions to determine its behavior after adequate reaction time and found to be as following

CBR Values %	**Lime Content %**		
	0	3	6
2.5 mm penetration	3.93	11.89	15.72
5 mm penetration	3.15	10.79	13.19

Table .5. CBR values with % lime

For CBR, it is observed that reasonable increase in value of CBR for a lime content of 6%.This value is increased from 3.93% to 15.72% and as a whole the value is increased 4 times with addition of lime content of 6%.This values are fairly satisfied with all necessary pavement design in Visakhapatnam port.

Figure 6, clearly indicates the CBR percentages with 2.5mm and 5mm penetrations. It is again observed that in all cases the CBR corresponding to 2.5mmis greater than 5mm penetration.

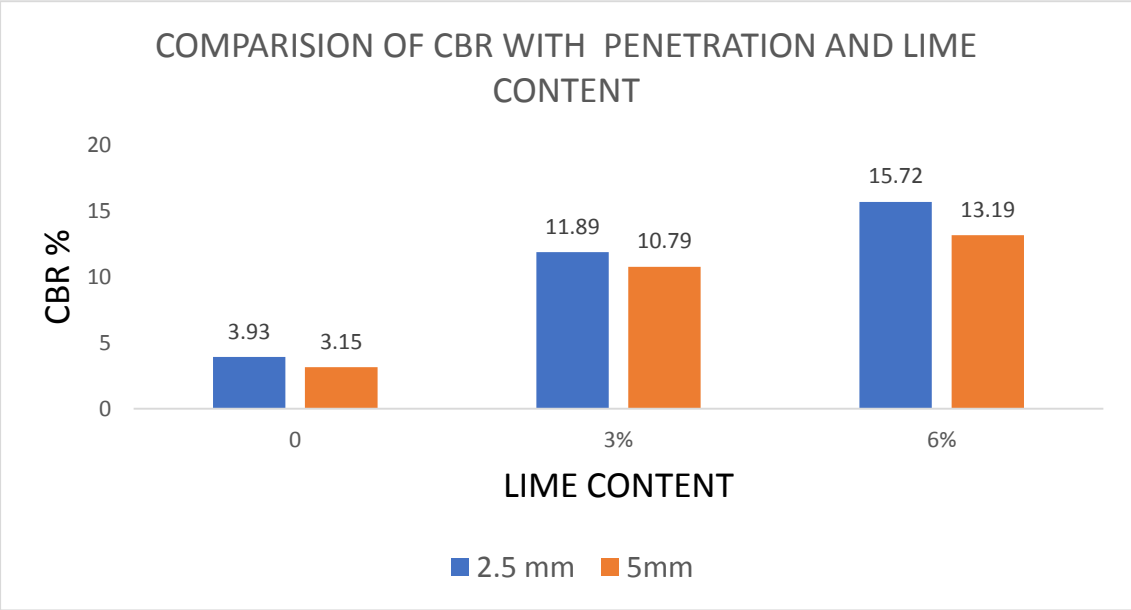

Figure.6. Variation of CBR with % Lime Content

V CONCLUSIONS

- From free swell index shows the soil had high potential for swelling. But with addition of lime the swelling nature was reduced.
- For the virgin soil, the MDD was found to be 1.312 g/cm3 and OMC was 22.42%. Though treated with lime, there was only marginal change in MDD but the OMC kept on increasing.
- It was found that the field moisture content was around 50% and it is highly impossible to attain MDD at that moisture content and it was also observed that with the increase in lime content, OMC to attain MDD is also increasing. So, from this we can conclude that with increase in lime content, more or less the field moisture content itself acts as OMC.
- From the UCS test, for natural soil the value of max axial stress and shear stress were found to be 1.462 kg/cm2 and 0.731 kg/cm2 respectively. Whereas there was an increase in the UCS value up to 9% of lime content with a maximum of 18.784 kg/cm2, 9.392 kg/cm2 in axial and shear resistance respectively. With the further increase in lime content there was slight reduction in the UCS values.
- The CBR value of virgin soil was found to be 3.93%. The CBR value with 3% and 6% lime was found to be 11.89 & 15.72 respectively. From this we can conclude that the resistance to penetration from the soil to the loads was substantially increasing. So, the soil treated with lime can be suggested for pavements and

runways as the CBR values are very high.

- When it comes to choose the optimum content of lime for better results considering all the factors, we would suggest that 9% of lime will do good for improving the engineering and mechanical properties of Port soil.

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