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Stabilization of soil by Using Fly Ash & Lime

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Abstract :- **For any typeof structure, the foundation is very important and it has to be strong to support the entire structure. In order for the strong foundation the soil around it plays a very critical role. To work on soils, we need to have proper knowledge about their properties and factors which affect their behavior. By consolidating under load and changing volumetrically along with seasonal moisture variation, these problems are manifested through swelling, shrinkage and unequal settlement. In this paper the experimental results obtained in the laboratory on expansive soils treated with industrial waste (fly ash and lime) are presented. A study is carried out to check the improvements in the properties of expansive soil with fly ash and lime in varying percentages. The test results such as liquid limit, standard proctor compaction, and differential free swelling test obtained on expansive clays mixed at different proportions of lime and fly ash admixture are presented and discussed in this paper. The results show that the stabilized clay has lesser swelling potential whereas increase in optimum moisture content has been observed.**

Keywords: **- Fly ash, lime, unequal settlement, expansive soil, stabilization.**

I. INTRODUCTION

Improving an on site soil's engineering properties is called soil stabilization. Soils containing significant levels of silt or clay, have changing geotechnical characteristics: they swell and become plastic in the presence of water, shrink when dry, and expand when exposed to frost. Swelling soil always create problem for lightly loaded structure, by consolidating under load and by changing volumetrically along with seasonal moisture variation. As a result the superstructures usually counter excessive settlement and differential movements, resulting in damage to foundation systems, structural elements and architectural features. In a significant number of cases the structure becomes unstable or uninhabitable. Even when efforts are made to improve swelling soil, the lack of appropriate technology sometimes results volumetric change that are responsible for billion dollars damage each year. It is due to this that the present work is taken up. The purpose was to check the scope of improving bearing capacity value and reduce expansiveness by adding additives. There are many methods of stabilizing soil to gain required engineering specifications. These methods range from mechanical to chemical stabilization. Most of these methods are relatively expensive to be implemented by slowly developing nations and the best way is to use locally available materials with relatively cheap costs affordable by their internal funds.

Site traffic is always a delicate and difficult issue when projects are carried out on such soils. Inother words, the re-use of these materials is often difficult, if not impossible. Once they have been treated with lime, such soilcan be used to create embankments or subgrade of structures, thus avoiding expensive excavation works and transport. Use oflime significantly changes the characteristics of a soil to produce long-term permanent strength and stability, particularly with respect to the action of water and frost. The mineralogical properties of the soils will determine their degree of reactivity withlime and the ultimate strength that the stabilized layers will develop.In many centuries, coal is the primary fuel in thermal power plant and other industry. The fine residue from these plants which is collected in a field is known as fly ash and considered as a waste material. The fly ash is disposed of either in the dry form or mixed with water and discharged in slurry into locations called ash ponds. The quantity of fly ash produced worldwide is huge and keeps increasing every day. Four countries, namely, China, India, United State and Poland alone produce more than 270 million tons of fly ash every year. This work has been done to see the effect on swelling aspect and on strength of some swelling soil by adding fly ash & lime in different proportion into it as additive. Soil stabilization improves the engineering properties of soil such as strength, volume stability and durability. The percentage addition of fine, coarse fly ash improves the strength of stabilized black cotton soil and exhibit relatively well-defined moisture-density relationship. It was found that the peak strength attained by fine fly ash mixture was 25% more when compared to coarse fly ash.[10] The addition of lime

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and class C fly ash to highly plastic clay also showed a reduction in shrinkage with increasing additive percentages. However, the addition of lime arrested the shrinkage at almost twice the rate of class C fly ash. The shrinkage arrest was not linear but occurred more readily with small amounts of additive and the rate of shrinkage arrest slowed as the amount of additive increased [2] It is seen that the thickness of pavement decreases by 66% as the CBR value goes on increasing. The improved CBR value is due to addition of Lime and Fly ash as admixtures to the BC soil. It also reduces the hydraulic conductivity of BC soil. There will be no need of drainage layer after treatment of BC soil as sub grade with lime and fly ash. In combination, the admixtures are beneficial for lower plasticity and higher silt content soils. In terms of material cost, the use of less costly fly ash can reduce the required amount of lime [5] This paper presents the results of the Experimental study on expansive soil by stabilizing it with fly ash and lime. Compaction test and free swelling index test on fly ash –lime mixed swelling soil have been performed. The clayey soil was mixed with 5% lime and varying percentage of fly ash (5%,10%,15%,20%,25%) to see the effect on swelling aspect and. optimum moisture content and modified dry density. The swelling potential, optimum moisture content and liquid limit decreases with increase in the fly ash content from 5% to 25%.

II. MATERIALS USED

- **Soil:** The properties of the expansive clay used in this investigation are given below:

Table:1

Properties	Soil
Grain size distribution	40% particles are below 2 micron
Liquid Limit	57%
Plastic limit	30.43%
Plasticity Index	26.57% (CH) According to USCS
Free swelling index	100%

- **Lime:** Industrial grade lime approx 4kgs was purchased. Lime which contain calcium oxide (cao) commonly known as burnt lime, or quicklime, is a white, caustic and alkaline crystalline solid at room temperature. As a commercial product, lime often also contains magnesium oxide, silicon oxide and smaller amounts of aluminum oxide and iron oxide.

- **Fly ash**: Fly ash and Bottom ash (waste material) was collected from the Thermal Power Plant in Nashik Fly Ash was collected from the ash pond about 150 m from the thermal power plant. About 12kg of fly ash was collected. The Bottom ash approx 10 kg was collected from the boiler area. The fly ash was sieved and dried, in case of Bottom ash only drying was required.

Results of geotechnical classification tests of fly ash:

Table:2

Properties	Rajghat Flyash
Grain size distribution	
1.Fine sand, 0.475-0.075mm (%)	21
2.Silt size, 0.075-0.002mm (%)	76
3.Clay size, 0.002mm (%)	3
Liquid Limit	50%

III. TESTS CONDUCTED

Fly Ash and Bottom Ash were mixed in a ratio of 4:1 In addition to the mixture, 5% of lime was also added to the soil mixture by weight. The percentage of Lime was maintained at a constant 5%by weight of the expansive soil sample, whereas the mixture of Fly Ash and bottom ash was increased in multiple percentages of 5% to obtain test samples on which tests were carried out and their properties studied. The proportions of flyash used along with the soil in the study are 5%, 10%, 15%, 20%and 25% respectively. The following Tests were performed in order to check the properties of the stabilized expansive soils:

- **Liquid limit**
- **Free Swelling Index (F.S.I)**
- **Standard Proctor Test**

All the tests were conducted in the controlled conditions as per the standard procedures given in the respective codes of Indian Standard.

IV. RESULTS AND DISCUSSION

Liquid Limit The liquid limit (LL) is the water content at which a soil changes from plastic to liquid behavior.

Table:3

S.No	Samples	Liquid Limit
1	SOIL SAMPLE +5%LIME +5%(FA+BA)	54.7
2	SOIL SAMPLE +5%LIME +10%(FA+BA)	51.1
3	SOIL SAMPLE +5%LIME +15%(FA+BA)	48.42
4	SOIL SAMPLE +5%LIME +20%(FA+BA)	47.67
5	SOIL SAMPLE +5%LIME +25%(FA+BA)	44.02

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From the above it shows that the liquid limit decreases with increase in the fly ash content from 5% to 25%. **Free Swelling Index (F.S.I):** Differential free swell test was performed in 100 ml cylindrical jar with 10 g soil sample. The graph showing variation of the readings for different samples is as follows:

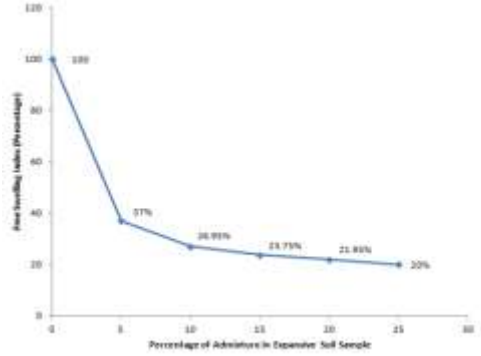
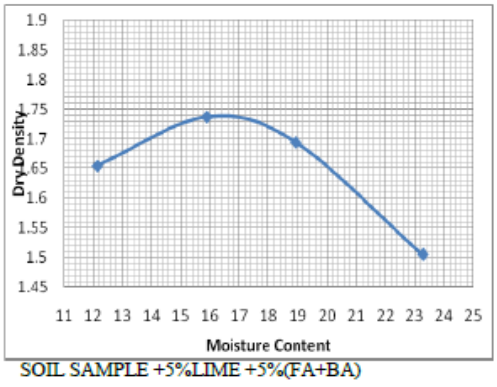


Fig 1

Standard Proctor Test The degree of compaction of a soil is measured in terms of its dry density. The degree of compaction mainly depends upon its moisture content, compaction energy and type of soil. For a given compaction energy every soil attains the maximum dry density at a particular water content which is known as optimum moisture content. The readings for different Percentage are as below:



SOIL SAMPLE +5%LIME +5%(FA+BA)

Fig 2

SOIL SAMPLE +5%LIME +10%(FA+BA)

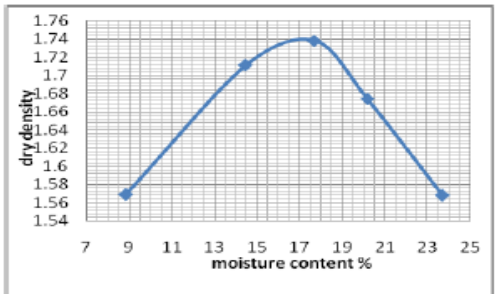


Fig 3

SOIL SAMPLE +5%LIME +15%(FA+BA)

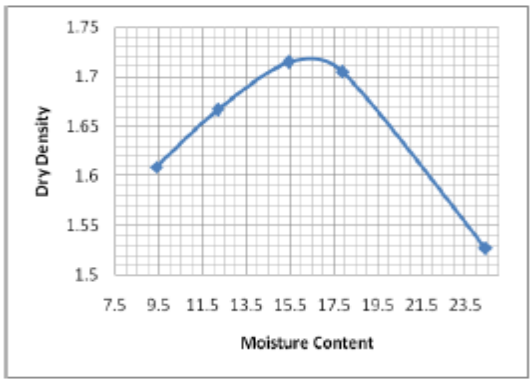


Fig 4

SOIL SAMPLE +5%LIME +20%(FA+BA)

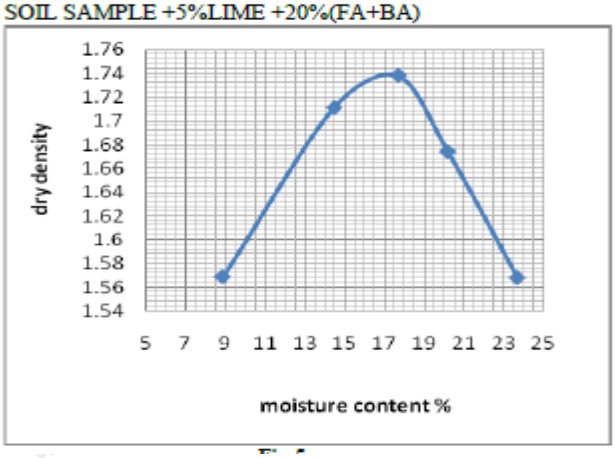


Fig 5

SOIL SAMPLE +5%LIME +25%(FA+BA)

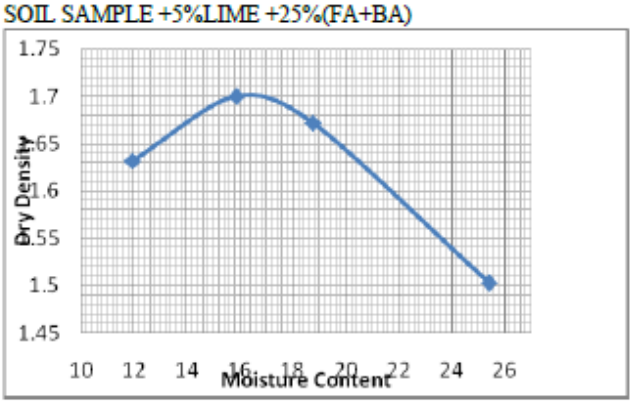


Fig 6

CONCLUSION

From the results it is clear that a change of the expansive soil texture takes place. When lime & fly ash are mixed with the expansive soil, the Plastic limit increases by mixing lime and liquid limit decreases by

mixing fly ash, which decreases plasticity index. As the amount of fly ash & lime increases there is apparent reduction in modified dry density & free swell index (shown in figure1 & 2) and increase in optimum moisture content. It can be concluded that the mixing lime & fly ash in specific proportion with the expansive soil is an effective way to tackle the problem of shrinkage, swelling and unequal settlement.

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