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Effect on Characteristics of Expansive Soil by Inclusion of Lime and Polypropylene Fiber

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ABSTRACT

Expansive soils are often encountered in many parts of the world. Black cotton soil is found in Maharashtra, Madhya Pradesh, Karnataka and Andhra Pradesh in our country. Such kind of soils generally include active clay minerals in low water content, enlarge in volume by absorbing the water through the surface and cause a great harm to the light structures such as roads , airports, embankments and cannel coatings etc. The expansive soils were encountered on the path of road pavements in the villages of vidarbha region in Maharashtra. The research done in the area, it is predicted that the soil has swelling nature and need soil improvement. Instead of replacing the expansive soil with granular soil, by stabilizing it with lime and polypropylene fiber at its original place which will decreases its swelling percentage. In order to improve the characteristics of expansive soil stabilized by lime and recently proposed polypropylene fiber described and reported in this paper. To investigate and understand the influence of the mixture of polypropylene fiber and lime on the engineering properties of a black cotton soil, nine groups of treated soil specimens were prepared and tested at four different percentages of fiber content i.e. 0.5%, 0.75%, 1% and1.5% by weight of the parent soil and five different percentages of lime i.e. 2%, 4%, 6%, 8%,10% by weight of the parent soil. These treated specimens were subjected to California bearing ratio test and swelling percentage. It was found that fiber content and lime content had significant influence on the engineering properties of the fiber–lime treated soil. An increase in lime content resulted in an increase of CBR value. On the other hand, an increase in lime content lead to a reduction of swelling potential. However, an increase in fiber content caused an increase in strength and decrease swell potential.

Keywords: Lime; Stabilization; Polypropylene Fibre (PPF); Expansive Soil; CBR;

I. INTRODUCTION

Soil stabilization broadly defined as the alteration or preservation of one or more soil properties to improve the engineering characteristics and performance of a soil, thus improving the load bearing capacity of a sub grade to support pavements and foundation. In recent years, soil stabilization is considered of great importance in many of the civil projects.

With the reduction of available land resources, more and more construction of civil engineering structures is carried out over weak or soft soil, which leads to the establishment and development of various ground improvement techniques such as soil stabilization and reinforcement.

Lime is the oldest traditional stabilizer used for soil stabilization. The mechanism of soil-lime treatment involves cation exchange, which leads to the flocculation and agglomeration of soil particles. The high pH environment then causes a pozzolanic reaction between the free Ca+2 cations and the dissolved silica and alumina. Lime-treated soil effectively increases the strength, durability and workability of the soil.

The primary purpose of reinforcing a soil mass is to improve its stability by increasing its bearing capacity, and by reducing settlement and lateral deformation. Conventional reinforcing methods make use of continuous inclusions of strips, fabrics, and grids into the soil mass. The random inclusion of various types of fibers is a modification of the same technique, in which the fibers act to interlock soil particles and aggregates in

a unitary coherent matrix. The most commonly used synthetic material; polypropylene fibre is used in this work. Polypropylene fibers are hydrophobic, non-corrosive and resistant to alkalis, chemicals and chlorides. At the optimum percentage of lime mix with the expansive soil, addition of polypropylene fibre can gives better result.

Certain types of clayey soils expand when they are wetted and shrink when dried. These are called as expansive soils. These soils swell by absorption of water during rainy season and shrink in summer when water evaporates out. Lightly loaded structures founded on these types of soils like single and two storied buildings, pavements, canal bed and linings, retaining structures etc. are damaged severely. As they are good soils for growth of cotton crop and their colour is black, they are called as black cotton soils in India. These soils are predominantly found in the states like Andhra Pradesh, Maharashtra, Karnataka, Madhya Pradesh, Uttar Pradesh, and Tamilnadu and in some part of Odisha.

The effects of polypropylene fiber on MDD, OMC, soaked CBR of expansive soil stabilized with PPF and lime has been found to be limited in literature. The objective of this paper is to study the effects of polypropylene fiber on Compactions property, CBR, of an expansive soil stabilized with optimum percentage of PPF and lime.

A. Problem Associated with B. C. Soil

Black Cotton soils are problematic for engineers everywhere in the world, and more so in tropical countries like India because of wide temperature variations and because of distinct dry and wet seasons, leading to wide variations in moisture content of soils. The following problems generally occur in black cotton soil

High Compressibility

Black Cotton soils are highly plastic and compressible, when they are saturated. Footing, resting on such soils under goes consolidation settlements of high magnitude.

Swelling

A structure built in a dry season, when the natural water content is low shows differential movement as result of soils during subsequent wet season. This causes structures supported by such swelling soils to lift up and crack.

Shrinkage

A structure built at the end of the wet season when the natural water content is high, shows settlement and shrinkage cracks during subsequent dry season.

II. METHODS AND MATERIALS

In order to investigate the effect of hydrated lime and polypropylene fiber on physical and engineering properties, both treated and untreated soil were subjected to similar laboratory test. These tests include Atterberge limits test, Compaction test, California bearing ratio test.
The materials used in the experiments are Expansive soil, Lime, Polypropylene fiber.

A. Expansive soil

The expansive soil used in the experimental work was brought from Shirala village Taluka Chandur bazar District Amravati.
Geo coordinates (Latitude-20.93, Longitude-77.75)

B. Lime

Commercially available quick Lime was obtained from local market and it was in powdered form.

C. Polypropylene Fibre

Fibrillated Polypropylene fiber having 12 mm length and aspect ratio 3 was purchased from the market. Its colour was white.

The samples which were used in the present study are shown in the following Figureures.

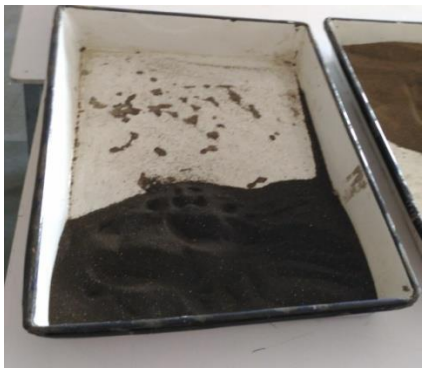

Figure A: Black Cotton Soil

Figure B: Fibrillated Polypropylene fibre

Figure C: Lime

The experimental work carried out to study the behavior of various percentages of lime and PPF, the influence of these materials were studied. Before addition of these materials all the geotechnical properties of virgin soil were find out as per IS Specification's and the various test results are shown in the below table.

Table I. Geotechnical Properties of soil Used in study

Sr. No	Engineering Properties	Values
1	Liquid Limit	71.75%
2	Plastic Limit	37.5%
3	Plasticity Index	34.5%
4	Specific Gravity	2.75
5	Optimum Moisture Content	19.4
6	Maximum Dry Density(g/cm^3)	1.46
7	IS Soil Classification	CH
8	Unconfined Compressive Strength(kg/cm^2)	
9	C.B.R (Unsoaked) (Soak)	3.86 0.85
10	Free Swell Index	39.52%

Experimental Programme

To improve, investigate, understand the influence of the mixture of polypropylene fiber and lime on the engineering properties of a black cotton soil, nine groups of treated soil specimens were prepared and tested at four different percentages of fiber content i.e. 0.5%, 0.75%, 1% and1.5% by weight of the parent soil and five different percentages of lime i.e. 2%, 4%, 6%, 8%, 10% by weight of the parent soil. These treated specimens were subjected to California bearing ratio test and swelling percentage. It was found that fiber content and lime content had significant influence on the engineering properties of the fiber–lime treated soil. An increase in lime content resulted in an increase of CBR value. On the other hand, an increase in lime content lead to a reduction of swelling potential. However, an increase in fiber content caused an increase in strength and decrease in swell potential.

III. TEST RESULTS AND DISCUSSION

CBR value and swelling potentials test results of Virgin soil and after adding lime and PPF in the soil, the Test results are summarized in table 3.

Table 3: California Bearing Ratio Test and swelling potential of specimens

Sr. No.	Description	Proctor test		CBR test
		OMC%	MDD%	Unsoak
1	Virgin soil	19.4	1.46	3.86
2	soil+2% lime	20.5	1.56	12.30
3	soil+4% lime	29.9	1.47	14.50
4	soil+6% lime	24.68	1.42	17.57
5	soil+8% lime	26.7	1.39	20.50
6	soil+10% lime	29.25	1.38	18.45

7	soil+0.5% PPF	20.48	1.44	7.38
8	soil+0.75% PPF	21.5	1.47	17.35
9	soil+1.0% PPF	22.2	1.4	12.89
10	soil+1.5% PPF	23.3	1.39	10.98
11	Soil+8% lime+0.5% ppf	26.02	1.39	20.21
12	Soil+8% lime + 0.75%ppf	27.8	1.41	22.93
13	Soil+8% lime +1%ppf	28.3	1.4	21.97
14	Soil+8% lime +1.5%ppf	28.9	1.38	19.11

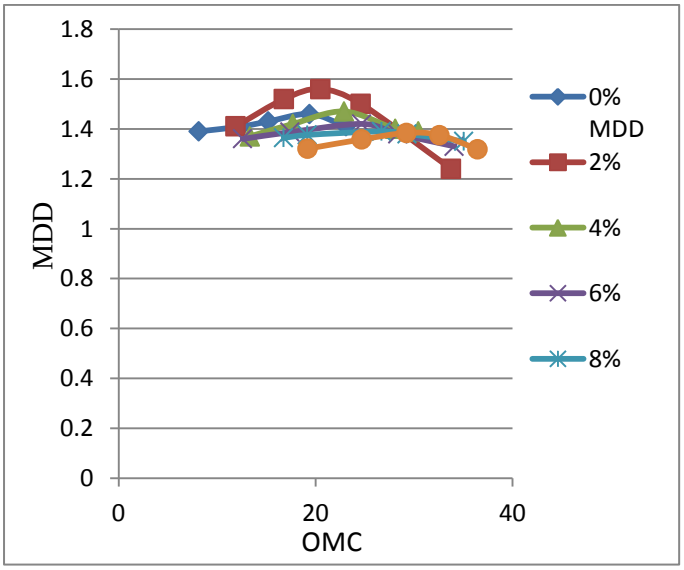

Figure 1: Proctor Test results With Different percentage of Lime

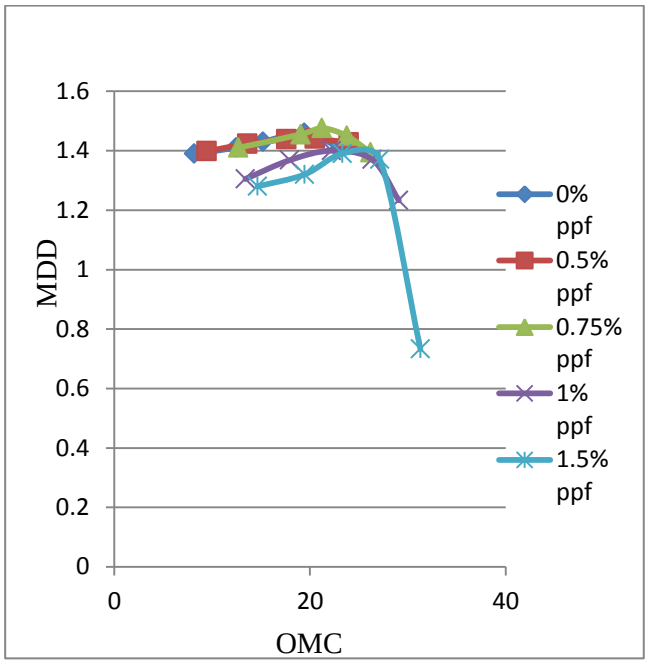

Figure 2: Proctor Test results With Different percentage of PPF

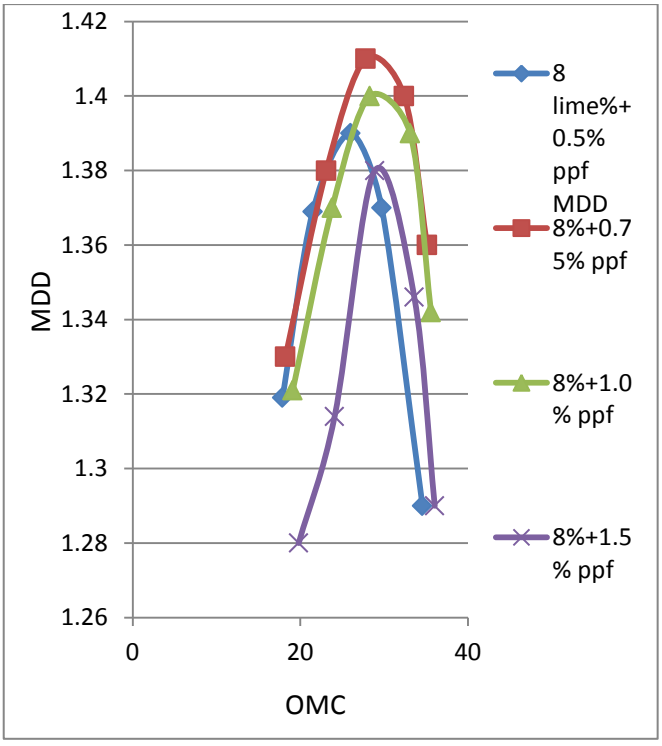

Figure 3: Proctor Test results With Different percentage of Composite material

From Figure No.1, 2 and 3, When Lime, PPF and compost of these two materials is added with different percentages in expansive soil Shows the variation in MDD and OMC.

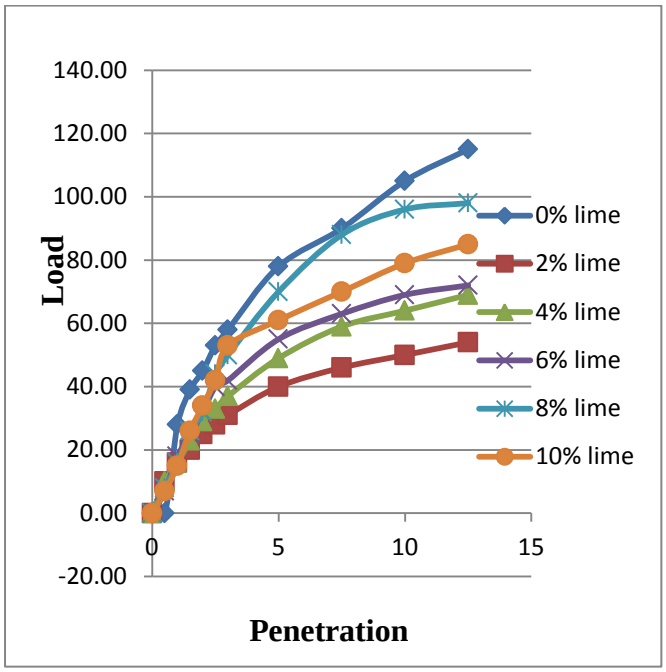

Figure 4: Unsoak CBR Values of different percentage of lime

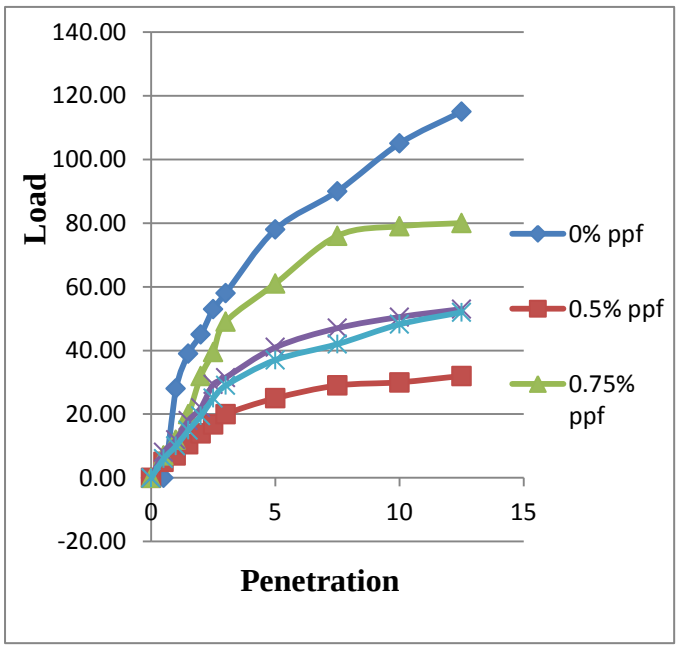

Figure 5 : unsoak CBR Values of different percentage of PPF

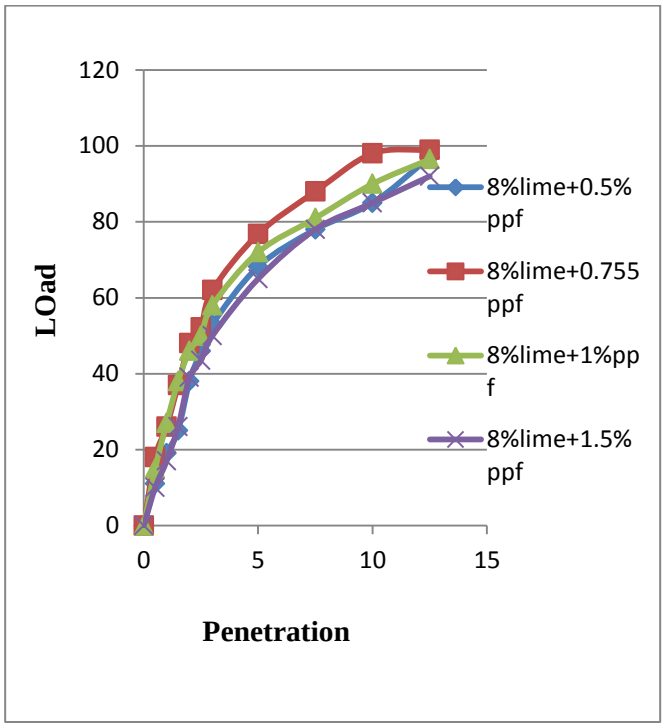

Figure 6: Unsoak CBR Values of different percentage of Composite material

From Figure 4,5 and 6, the unsoak cbr value increases at 8% of lime content by dry weight of soil, at 0.75% PPF and 8% Lime+0.75% PPF Composite material, the CBR value increases.

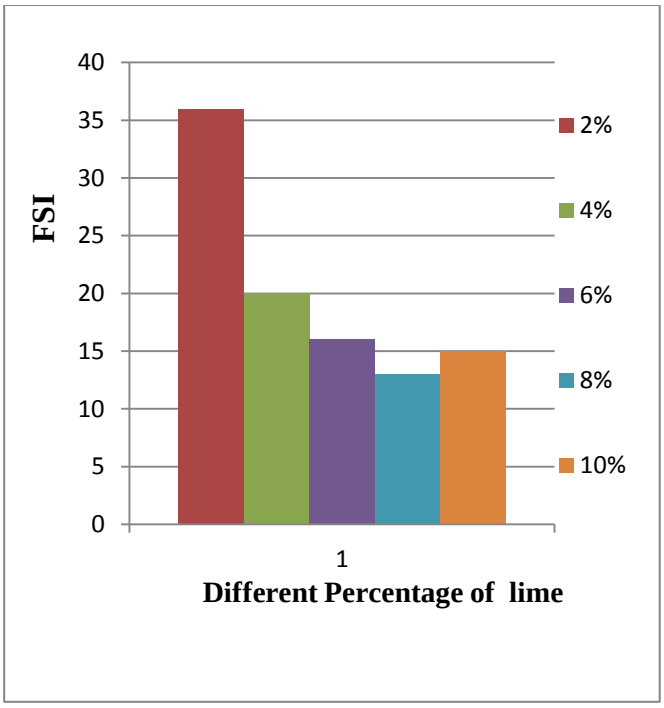

Figure 7: Free Swell Index at Different Percentage of Lime

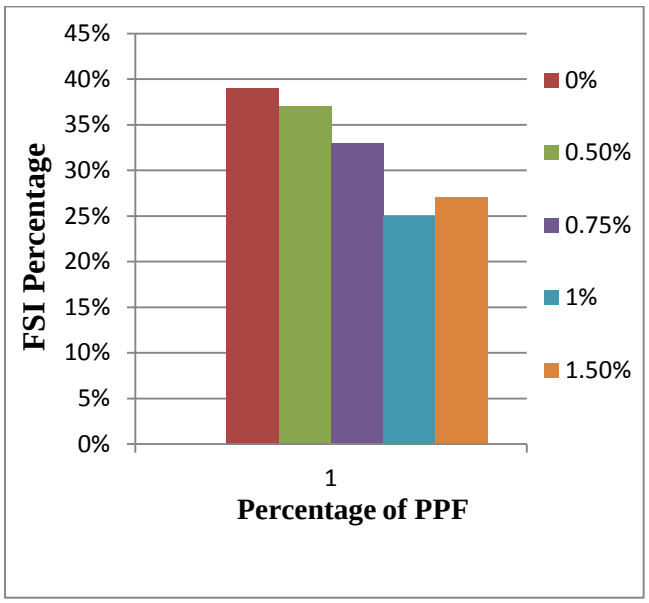

Figure 8: Free Swell Index at Different Percentage of PPF

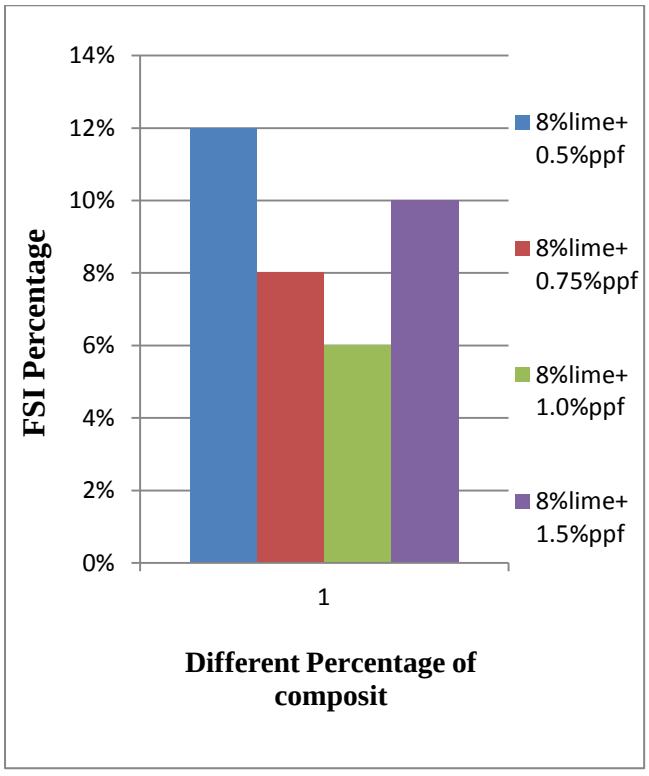

Figure 9: Free Swell Index at Different Percentage of composite

From the Figure 7,8 and 9, it is shown that the free swell index of soil is reduced by adding 8% lime, 0.75% PPF and 8% lime+0.75% PPF Composite material.

IV. CONCLUSION

The Effects of both polypropylene fiber and lime on the California bearing Ratio Test and swelling of expansive soil have been studied.

It is shown from the test results, that the addition of the lime and polypropylene fibers causes the beneficial changes in the engineering properties of soil. From CBR test value it is found that the unsoak CBR value on 8% lime contain increased by 18.8% and 0.75% PPF is added then unsoak cbr value is increase by 22.24%. But when 8% Lime and 0.75% PPF is added combine into the soil it gives better results and unsoak CBR value increased by 16.8%. Also at 8% Lime and 1% PPF addition, hence it is observed that swelling of soil is reduces.

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