International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 8, August-2018

AN EXPERIMENTAL STUDY ON STRENGTH BEHAVIOUR OF EXPANSIVE SOIL STABILIZED WITH POLYESTER FIBER AND LIME

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Abstract---In vast areas the expansive soils are located along the central India, which foist enormous construction problems to geotechnical engineers.Expansive soil has a clay mineral Montmorillonite,can imbibe large amount of water and undergo volume changes causing shrinkage and seasonal heave in foundations, pavements, embankments, retaining walls that generate vandalization thestructure thatimplies loss of crores of money. To reduce its impact in fields there is necessary to improving the soil characteristics by stabilization. Now a day's synthetic fiber such as polyester fibers are used as stabilizing material those are fabricated from plastics. Plastics create environmental pollution as per 2018, about 380million tonnes of plastic produced worldwide each year.By recycling the plastic which can be used as stabilizing material in the configuration of polyester fiber. Here lime is also used as additive increasing plastic property to soil. The current study assign with the strength behavior of the expansive soil. The accomplishment of polyester fiber and lime for make better the strength attributes to expansive soil. The laboratory tests are bringing off and conclusion are noticeable in this research paper.

Index Terms: Expansive Soil, Polyester Fiber, Lime,OMC, MDD,CBR

I.INTRODUCTION

Origin of Expansive Clay: In tropical volcanic environments expansive soils high in alumina is deposited in depressed areas. The characteristics of expansive clay are differ significantly from natural soil.Expansive soils are also called as black cotton soils. Black cotton soils consists clay minerals like Montmorillonite, kaolinite, illite, and chemicals like calcium carbonate, iron oxide, and organic matter. The predominant mineral of black cotton soils is Montmorillonite. The expansive clays are found in Gujarat, Rajasthan, Maharashtra,Telangana, Andhra Pradesh,Karnataka, Madhya Pradeshthese soils are highly saturated, weak,have low shear strength and low density and expansive in nature, expansive clay is clay soil that is prone to large volume change that are related to changes in water content. In the field,expansive clay soil can be recognized in the dry climates by deep cracks, in roughly polygonal patterns. In the ground surface, when expansive soils become wet and expand, the resulting expanding pressure can cause uplift against concrete slabs and foundation footings causing a wide variety of damages to buildings and surrounding areas. These damages may include water leaking into basements, cracks in interior dry wall, broken pipes and water lines. Proper remedial measures are to be adopted to modify the soil or to reduce its detrimental effects if expansive soil are identified in the project. Remedial measures to expansive soil by technique stabilization. Stabilization is a method to improve the weak soil by using different additives and chemicals ,by this process the weak soil can be shaped as strengthen soil in form of high shear strength, density, and low compressibility,permeability, and also absorbing less quantity of water from underneath soil. This creates swell/shrink behavior in the upper portion of the foundation. When expansive soils become wet and expand. The resulting expanding pressure can cause uplift against concrete slabs and foundation footings causing a wide variety of damages to buildings and surrounding areas. These damages may include water leaking into basements, Cracks in interior dry wall, broken pipes and water lines. Proper remedial measures are to be adopted to modify the soil or to reduce its detrimental effects if expansive soil are identified in the project. Remedial measures to expansive soil by technique Stabilization. In the stabilization method there are different methods,those are pounding, preloading, grouting, blasting, and drilling sand columns etc.Additives such as cement, Lime, Quarry dust etc.
Several researches have been made to improve the strength of the expansive soils Ranjan(1996) et al ,nelson and miller(1992) et al, manoj and Pratap(2010) et al, kaniraj and vasanth(2010) et al, Kumar(1999) et al,mandal and murti (1989) et al and experimental studies to improve the proportions of expansive soils using different admixtures.

II. OBJECTIVES OF THE STUDY

- To determine the properties of the expansive soil.
- To evaluate the performance of expansive soil when treated with polyester fiber of varying length at different percentage.
- To evaluatethe performance ofthe expansive soil when treated with polyester fiber and varying length of lime.

III. MATERIALS USED

*A. Expansive Soil***:** The soil used in this study is expansive soil obtained from Amalapuram,East Godavari district,Andhra Pradesh at a depth 0f 1.5m from ground level. The index and engineering properties of expansive soil are determined as per IS code of practice.

B. Polyester Fiber: polyester fiber is the latest and largest growing industry alternate or many requirements across the world with the far superior properties compared to natural fibers. The polyester fibers used in this investigation was brought from polyester fiber manufactures, suppliers, and exports in Hyderabad, Telangana, India.The quantity of PF was varied from 0% to 1.5 %(6mm, 12mm) by dry weight.

*C. Lime:*Lime was brought from Kakinada, Andhra Pradesh, India.

TABLE1

PHYSICAL PROPERTIES OF POLYESTER FIBER

S. No	Property	Value
1	**Colour**	*White*
2	**Specific Gravity**	*1.38*
3	**Structure**	*Crystalline*
4	**Melting Point**	*Up to 240°-260°*
5	**Diameter**	*Up to 20-30µm*
6	**Length**	*Up to 30-40mm*

TABLE 2

CHEMICAL COMPOSITION OF LIME

S. No	Property	Value (%)
1	**Silicon Oxide (SiO_2)**	*2.5*
2	**Aluminum Oxide(Al_2O_3)**	*1.5*
3	**Ferrous Oxide(Fe_2O_3)**	*2*
4	**Calcium Oxide (CaO)**	*66.08*
5	**Magnesium Oxide(MgO)**	*1.5*
6	**Sodium Oxide(Na_2O)**	*0.5*
7	**Physical Appearance**	*White dry powder*
8	**Specific Gravity**	*2*

IV. LABORATORY TESTS

The laboratory studies were carried out on the samples of expansive soil, Expansive soil+0.5% of polyester fibers (PF) and expansive soil+0.5%of polyester fibers (PF) +1.5% of lime

1.Liquid Limit

Liquid limit test was conducted on expansive soil,expansive soil+0.5% of PF and expansive soil+0.5%of PF+1.5% of lime, Using Casagrande liquid limit apparatus as per the procedure in IS:2720 part 4(1970)

2.Plastic Limit

Plastic limit test was conducted on expansive soil, Expansive soil+0.5% of PF and Expansive soil+0.5%of PF+1.5% of lime, as per procedure laid down in IS: 2720 part (1970).

3. Differential Free Test

Differential free swell test was conducted on expansive soil carried out as per IS: 2720(Part III-1980).

4. Specific Gravity Test

Specific gravity test was carried out by Pycnometer as per IS: 2720 Part 3(1980)

5. Proctors Standard Compaction Test

Proctors compaction test was done as per IS: 2720 Part 6(1974)

6. California Bearing Ratio Test

CBR test was conducted on expansive soil, expansive soil+ 1.5%PF and expansive soil+1.5%PF+1.5% of lime. The soaked CBR test is conducted after immersing in water for 4 days. California bearing ratio test was conducted as per IS: 2720Part16 (1979)

V. RESULTS AND DISCUSSIONS

The Index andEngineering Properties of expansive clay soil are determined as per IS code of practice and are presented in Table 3.

TABLE3 PROPERTIES OF EXPANSIVE SOIL

S. No	Property		Symbol	Value
1	Gravel (%)		-	*0.61*
2	Sand (%)	coarse	-	*0.69*
		Medium	-	*2.38*
		fine	-	*9.22*
3	Fines (%)	Silt (%)	-	*38.57*
		Clay (%)	-	*48.53*
4	Liquid Limit (%)		**LL**	*60.00*
5	Plastic Limit (%)		**PL**	*29.30*
6	Plasticity Index (%)		**PI**	*30.70*
7	Soil Classification		-	*CH*
8	Specific Gravity		**G**	*2.67*
9	Differential Free Swell		**DFS**	*110.00*
10	Optimum Moisture Content (%)		**OMC**	*28.29*
11	Maximum Dry Density(g/cc)		**MDD**	*1.49*
12	Cohesion (kg/cm2)		**c**	*0.55*
13	Angle of Internal Friction		**Ø**	*17.00*
14	California Bearing Ratio (%)		**CBR**	*2.24*

A. Proctor Compaction Test Results for Untreated Expansive Soil

TABLE4
VARIATION OF MDD &OMC OF EXPANSIVE SOIL

S. No	Dry Density (g/cc)	Water Content (%)
1	1.361	26.58
2	1.435	27.21
3	**1.490**	**28.29**
4	1.445	29.24
5	1.325	30.51

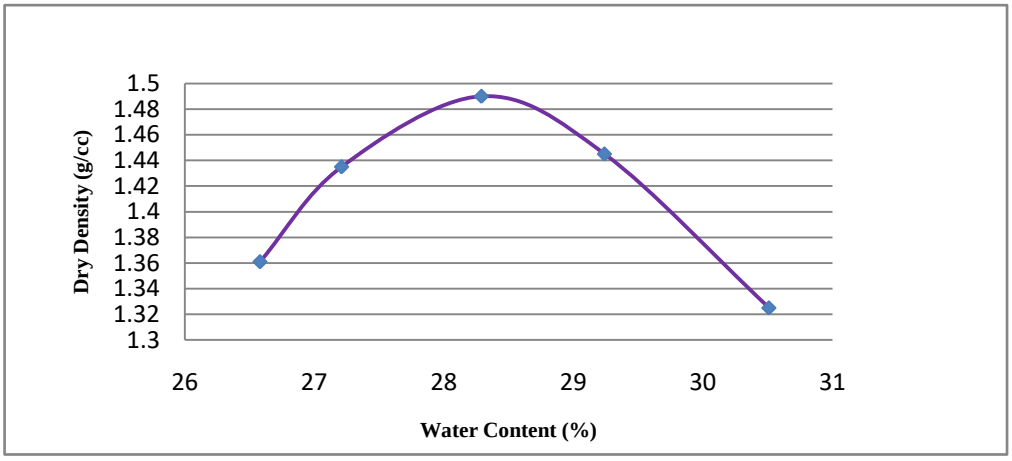

Fig.1 MDD & OMC of expansive soil

B. Proctor Compaction Test Results for Expansive Soil treated with varying Percentage of Polyester Fiber (6mm, 12mm)

TABLE 5

MDD &OMC OF SOIL AND % OF PF (6MM, 12MM)

Soil+ Length of Fiber	%of PF	MDD(g/cc)	OMC (%)
6mm	0.5	1.486	18.06
	1	1.462	20.13
	1.5	**1.453**	**20.93**
12mm	0.5	1.564	16.82
	1	1.534	18.32
	1.5	**1.513**	**20.46**

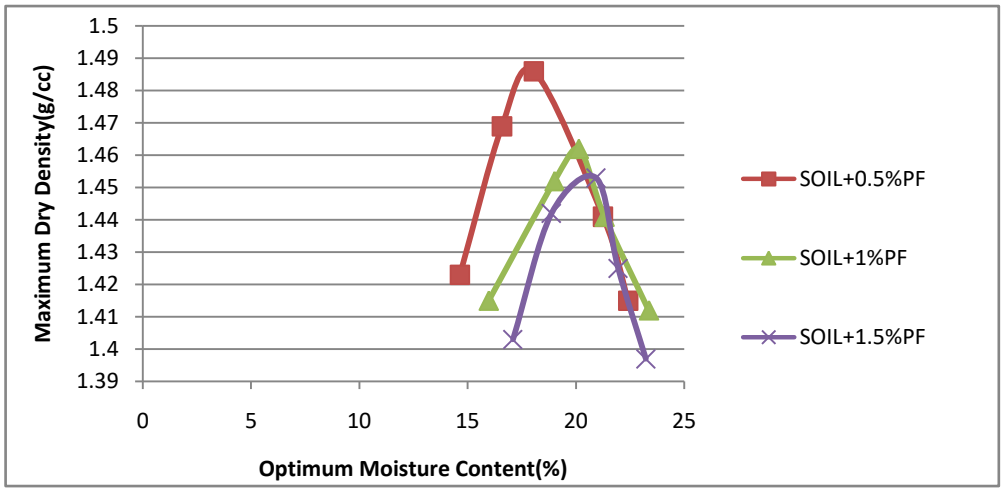

Fig.2MDD & OMC of soil+% of PF (6mm)

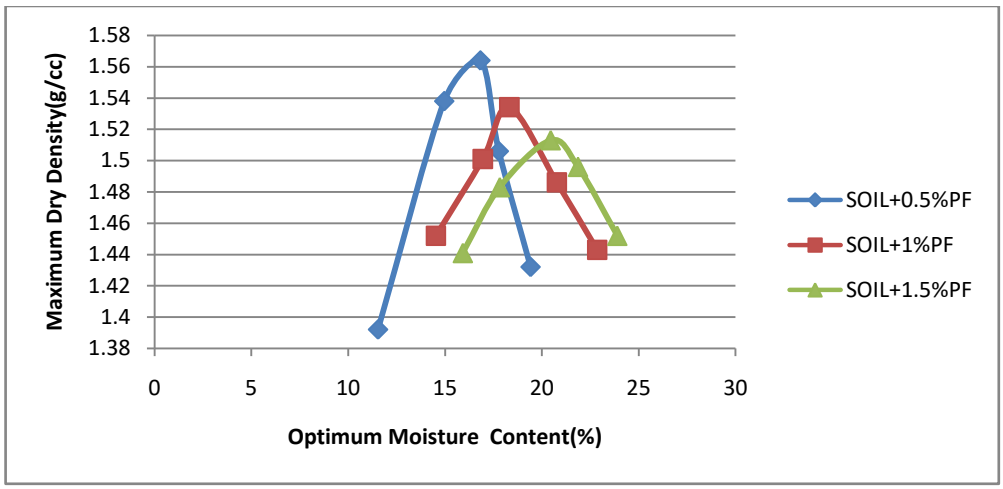

Fig.3 MDD &OMC of soil+% of PF (12mm)

C. California Bearing Ratio values of Untreated Expansive Soil and Expansive Soil treated with various Percentage of Polyester Fiber (6mm, 12mm)

TABLE 6

CBR OF UNTREATED SOIL AND % OF PF (6MM, 12MM)

S. No	Soil+%of PF (6mm,12mm)		CBR (%)
1	Soil		2.24
2	Soil+% of PF (6mm)	0.5	3.58
		1.0	4.03
		1.5	**4.48**
3	Soil+%of PF (12mm)	0.5	4.48
		1.0	5.37
		1.5	**6.72**

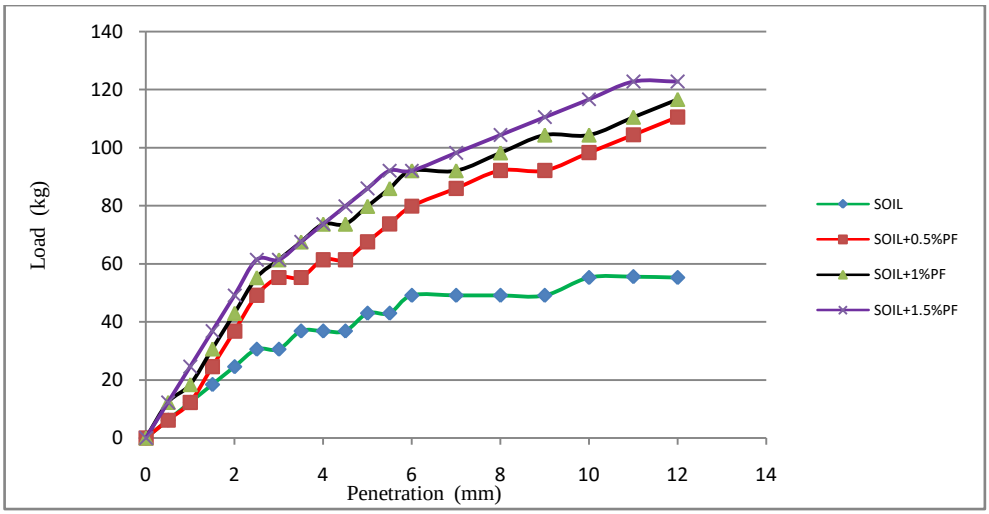

Fig.4CBR values of treated soil and % of PF (6mm)

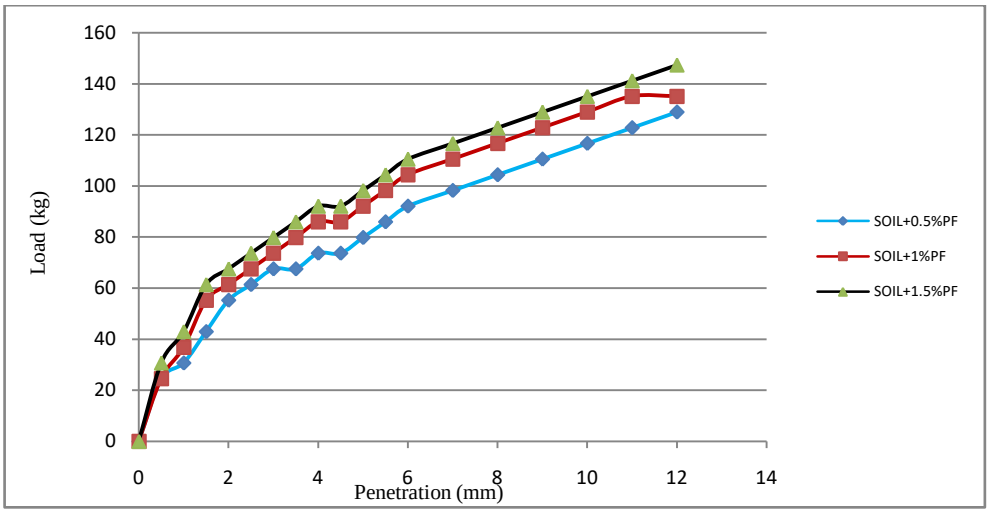

Fig.5CBR values of treated soil and % of PF (12mm)

From above values the MDD is optimum at 0.5% of PF and CBR is maximum at 1.5% of PF.

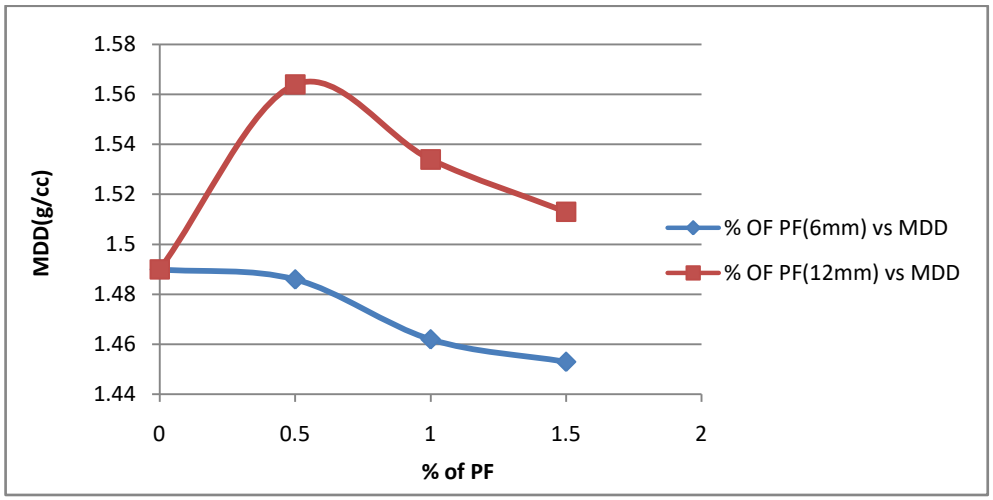

Fig.6 Variations % of PF and MDD

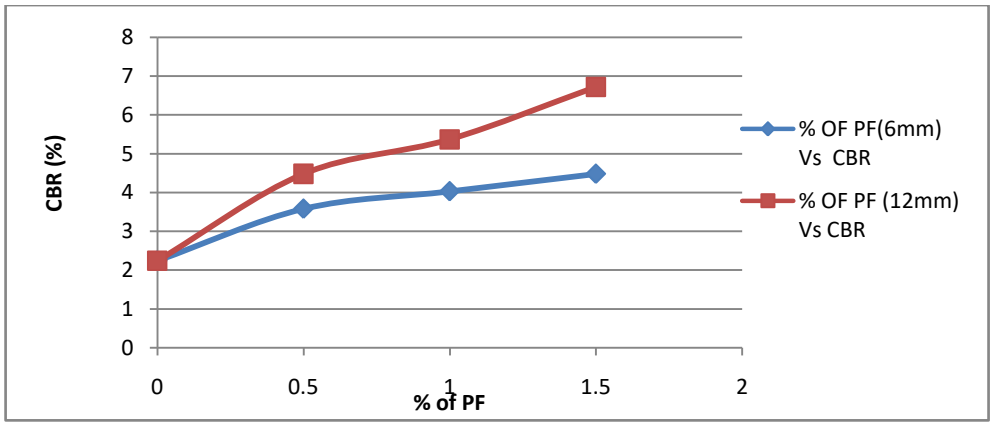

Fig.7 Variations of %of PF and CBR

D. Proctor Compaction Test Results for Expansive Soil treated with 0.5% of Polyester Fiber (6mm, 12mm) and varying Percentage of Lime

TABLE 7
MDD & OMC 0.5 % OF PF (6MM, 12MM) AND % OF LIME

S. No	Fiber Length	Soil+0.5%of PF +% of Lime	MDD(g/cc)	OMC (%)
1	6mm	5	1.955	20.56
		10	2.032	19.87
		15	**2.076**	**18.43**
		20	2.042	18.02
2	12mm	5	2.041	20.43
		10	2.104	22.53
		15	**2.131**	**21.02**
		20	2.094	20.53

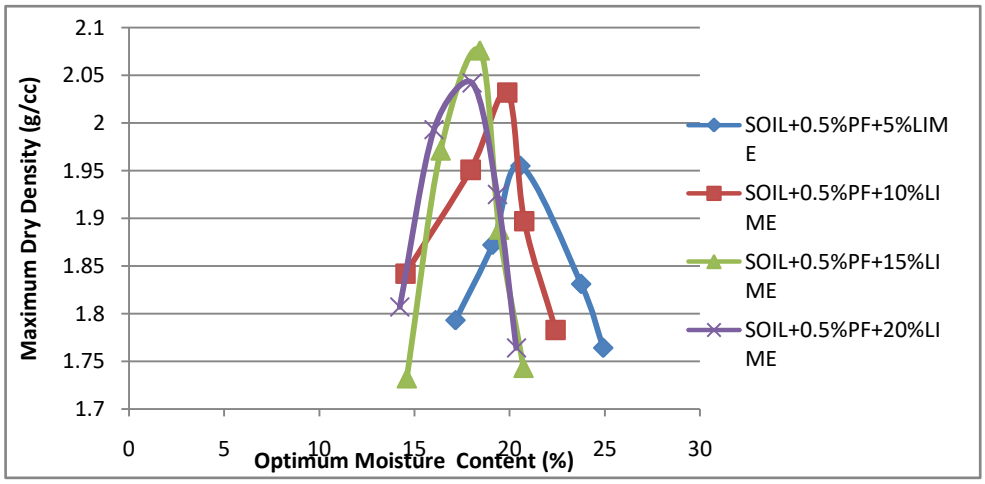

Fig.8 MDD & OMC of 0.5% of PF (6mm) and % of Lime

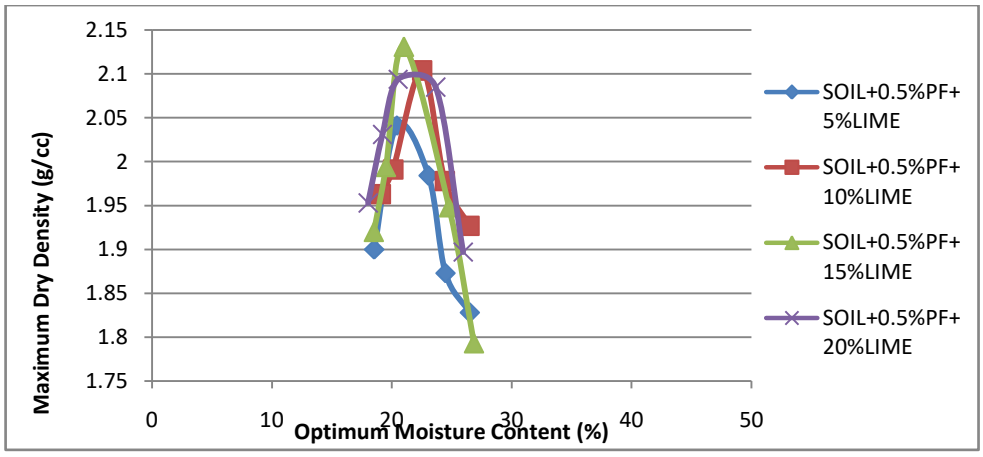

Fig.9MDD & OMC 0.5% of PF (12mm) and % of Lime

E. California Bearing Ratio Values for Expansive Soil treated with 1.5% of Polyester Fiber (6mm, 12mm) and varying Percentage of Lime

TABLE 8

CBR 1.5 % OF PF (6MM, 12MM) AND % OF LIME

S. No	Soil+1.5%of PF+% of Lime		CBR (%)
1	6mm	5	6.72
		10	7.17
		15	**8.51**
		20	8.06
2	12mm	5	7.61
		10	8.96
		15	**9.41**
		20	8.96

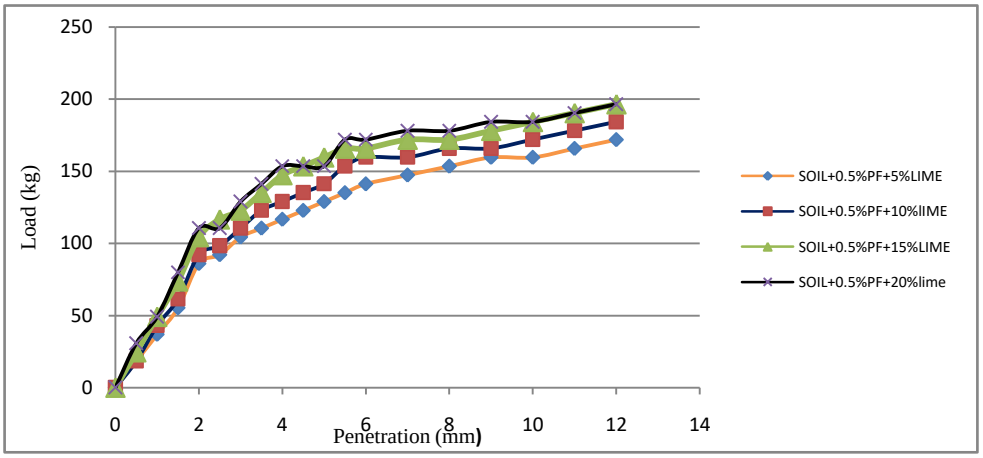

Fig.10 CBR of 1.5% of PF (6mm) and % of Lime

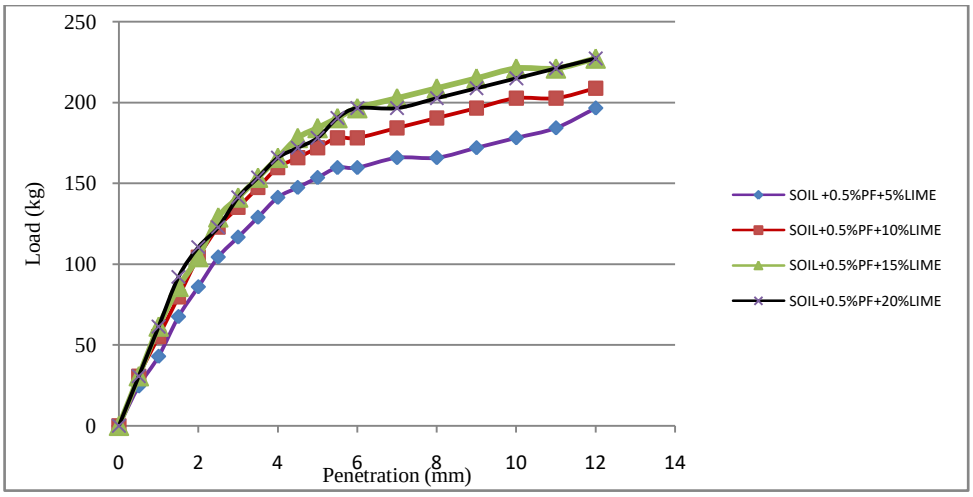

Fig.11CBR of 1.5% of PF (12mm) and % of Lime

F. Properties of Treated Soil with 0.5% of Polyester Fibers and 0.5% of Polyester Fibers + 15% of Lime

TABLE 9

Properties Of treated soil with 0.5% of PolyesterFiber and 0.5% of polyester fiber + 15% of Lime

S. No	Property	SOIL+0.5% of PF		SOIL+0.5% of PF+15% of Lime	
		6mm	12mm	6mm	12mm
1	Liquid Limit (LL)	56.42	53.23	45.35	42.59
2	Plastic Limit (PL)	32.47	32.93	39.91	40.54
3	Plasticity Index (PI)	23.95	18.3	5.44	2.05
4	specific Gravity (G)	2.67	2.72	2.76	2.86
5	Differential Free Swell (DFS)	100	75	52	30
6	Maximum Dry Density (MDD)	1.486	1.564	2.076	2.131
7	Optimum Moisture Content (OMC)	18.06	16.82	18.43	21.02
8	Cohesion(C)	0.48	0.43	0.36	0.31
9	Angle of Internal Friction(ϕ)	19	23.6	28.4	36.8

VII. CONCLUSION

- It is found that the Liquid Limit of the expansive soil has been decreased by5.96% and 11.28% on addition of 0.5% of polyester fiber 6mmand 12mm respectively.
- It is observed that the Liquid Limit of the expansive soil has been decreased by24.41% and 29.01% on addition of 0.5% of PF+1.5% of limeof 6mm and 12mm respectively.
- It is noticed that the Plastic Limit of the expansive soil has been increased by 10.8%and 19.2% on addition of 0.5% of polyester fiber of 6mm and 12mm respectively.
- It is found that the Plastic Limit of the expansive soil has been increased by 36.21% and 38.26% on addition of 0.5% of PF+1.5% of limeof 6mm and 12mm respectively.
- It is observed that the Plasticity Index of the expansive soil has been decreased by 22.5% and 40.39% on addition of 0.5% of polyester fiber of 6mm and 12mm respectively. And Plasticity Index of the expansive soil has been decreased by82.28% and 93.32% on addition of 0.5% of PF+ 1.5% of lime of 6mm and12mm respectively.
- It is found that the MDD of the expansive soil has been decreased by 0.26% and increased by 4.96% on addition of 0.5% of polyester fiber of 6mm and 12mm respectively.
- It is found that the MDD of the expansive soil has been increased by 39.32% and 43.02% on addition of 0.5% of PF+1.5% of lime of 6mm and 12mm respectively.
- It is observed that the CBR of the expansive soil has been increased by100% and 200% on addition of 1.5% of polyester fiber of 6mm and 12mm respectively.
- It is observed that the CBR of the expansive soil has been increased by 279%and 320% on addition of 1.5% of PF+1.5% of lime6mm and 12mm respectively.
- It is observed that the Cohesion of the expansive soil has been decreased by 12.7% and 21.8% on addition of 0.5% of polyester fiber 6mm and 12mm respectively.
- It is observed that the Cohesion of the expansive soil has been decreased by and 34.54% and 43.63% on addition of 0.5% of PF+1.5% of lime 6mm and 12mm respectively.
- It is observed that the Angle of Internal Friction of the expansive soil has been increased by 11.76% and 38.82% on addition of 0.5% of polyester fiber 6mm and 12mm respectively
- It is observed that the Angle of Internal Friction of the expansive soil has been increased by and 67.05% and 116.47% on addition of 0.5% of PF+1.5% of lime 6mm and 12mm respectively.
- It is observed that the DFS of the expansive soil has been decreased by 9.09% and 31.8% on addition of 0.5% of polyester fiber 6mm and 12mm respectively.
- It is observed that the DFS of the expansive soil has been decreased by and 52.72% and 72.72% on addition of 0.5% of PF+1.5% of lime 6mm and 12mm respectively.

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