Scientific Journal Impact Factor (SJIF) : 3.518
International Journal of Modern Trends in Engineering and Research
IJMTER
ISSN (ONLINE) : 2349 - 9745
ISSN (PRINT) : 2393 - 8161

STUDY ON EFFECT OF POLYPROPLENE FIBER ON BLACK COTTON SOIL

Geethu Elsa Thomas[1] and Josy John[2]
[1,2]*Assistant Professor, Department Of Civil Engineering, Mount Zion College Of Engineering,Kadammanitta, Pathanamthitta*

Abstract— This paper describes the compaction and strength behavior of black cotton soil (BC soil) reinforced with polyproplene fibers. The extent of increase in strength of black cotton soil, for varying diameters (6mm and 12 mm) and percentages (0.50%, 0.75%, 1%, 1.25% and 1.50%) of polypropylene fibres were found out by conducting unconfined compressive strength test and Atterbergs limit test. The effect of polypropylene fibre on improving the strength of black cotton soil was found. Comparison of the properties of soil before and after the addition of fibre was made.
Keywords— load-deformation behavior, surface friction, interlocking, consolidation characteristics, polypropylene fibre, clayey soil,

I. INTRODUCTION

The centuries old problem of land scarcity in the vicinity of existing areas often necessitates the use of sites with soils of marginal quality. These include soft clays, highly organic soils and others. They are prone to shear failure and excessive settlement. In addition, the areas underlain by such soils frequently are subjected to flooding, so construction projects often require placing a fill to raise the ground surface to suitable elevation. Unfortunately, the weight of such fills can cause large settlements. In many cases these sites can be utilized for the proposed projects by using some kind of soil improvement. Several attempts have already been made by researchers to understand the mechanism of randomly oriented discrete inclusions incorporated into soil, to improve its load-deformation behavior. This can be achieved by interacting with soil particles mechanically through surface friction and also by interlocking. However, in the present study an attempt has been made to improve the strength as well as the consolidation characteristics of clayey soil (black cotton soil) by the addition of polypropylene fibre.

1.1Black cotton soil

Black cotton soil is a type of clayey soil which expands when they are wetted and shrink when dried. 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.

1.2 Polyproplene fiber

In order to resist the weakness of stabilized soil–cement against tensile strength it is necessary to introduce another material that has a power to resist tensile stresses. Plastic is made of synthetics polymers that are comparable to plastic fibers that are commonly used to resist tensile stress in soil improvement. In general strips of waste plastic used previously to improve the physical and mechanical properties of soil such as shear strength, tensile strength, load penetration resistance (CBR – California bearing ratio), and friction angle .

II. EXPERIMENTAL WORK

2.1 Materials

2.1.1 Soil Sample

Natural clay collected from Reddiyarpati was used. The soil sample thus collected were labelled properly and stored in laboratory. This soil were then air dried at room temperature and

there after soil samples were powdered and sieved through 425 micron sieve before the same is used for laboratory tests. These physical properties of the soil are determined as per IS specifications. The soil is classified as CH (as per IS 1498-1970) indicating that the clay is of high plasticity. The grain size distribution of the soil is as shown in Figure1.

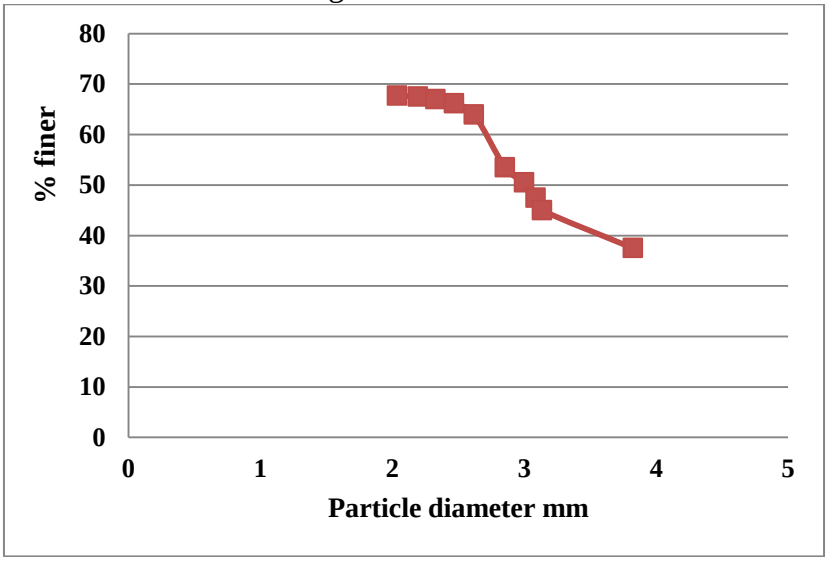

Figure 1.The Grain Size Distribution Of The Soil

2.1.2 Polypropylene fibre

Polypropylene fibre has the following unique advantages:

- lime and cement, it can be dispersed easily into soil.
- The presence of short discrete polypropylene fibre in soil can prevent the occurrence of potential weak structural planes

The properties of the polypropylene fibres are provided by the supplier-Reliance Industries Ltd, Mumbai as shown in Table1.

2.2 Tests For Engineering Properties

2.2.1 Tests Conducted

Table1. Properties Of The Polypropylene Fibres

Property	**Value**
Length (mm)	6 and 12
Average diameter (mm)	0.034
Density (g/cc)	0.91
Tensile Strength (MPa)	450
Heat Resistance (^{0}C)	< = 130
Acid and alkali resistance	Very good

- Natural moisture content

- Field density
- Specific gravity
- Liquid limit
- Plastic limit
- Shrinkage limit
- Plasticity index
- Grain size analysis
- One dimensional consolidation test
- Unconfined compressive strength test
- Triaxial compression test
- CBR test

Table2. Properties Of The Tested Soil

Properties		**Values**
Natural moisture content (%)		58.32
Field density (kN/m^3)		17.5
Specific Gravity		2.9
Liquid Limit (%)		61%
Plastic Limit (%)		55.1%
Shrinkage Limit		24.53%
Plasticity Index		5.9%
Grain size Analysis	Clay content	61.8%
	Silt Content	6.08%
One-dimensional Consolidation test	Compression index	0.183
	Coefficient of Compressibility (m^2/kN)	0.12
	Coefficient of volume change (m^2/kN)	.075
	Coefficient of permeability (cm/s)	4.368*10^{-5}
	Unconfined compressive strength (KN/m²)	6.58
	Cohesion (KN/m²)	3.29

III. RESULTS

The summary of the experiments are shown below. The extent of increase in strength of black cotton soil, for varying diameters (6mm and 12 mm) and percentages (0.50%, 0.75%, 1%, 1.25% and 1.50%) of polypropylene fibres is shown below.

- **6mm Fiber**

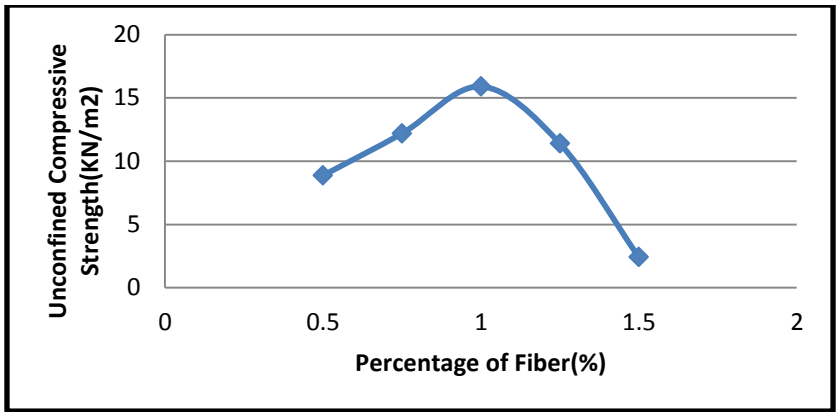

Figure2. Unconfined Compressive strength Vs. Percentage fibre

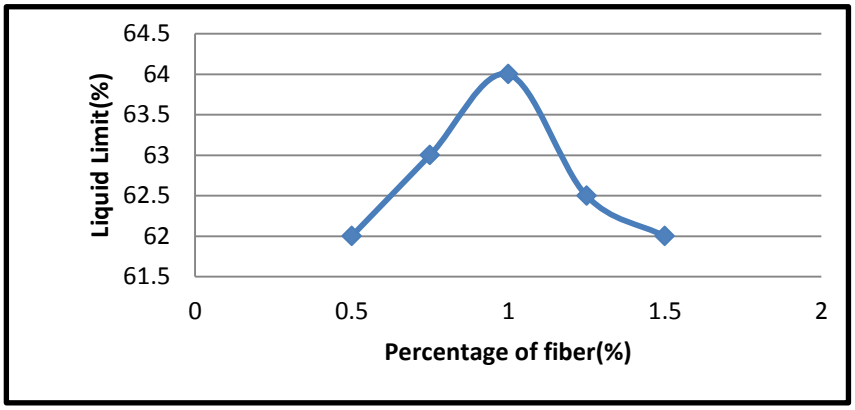

Figure3. Liquid Limit Vs. Percentage fibre

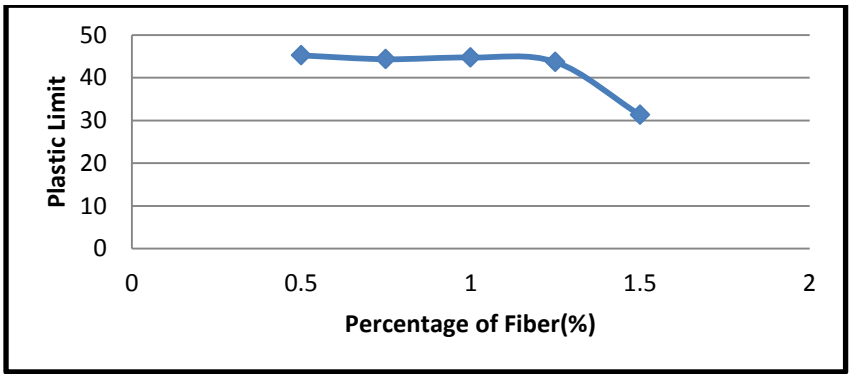

Figure4. Plastic limit Vs. Percentage fibre

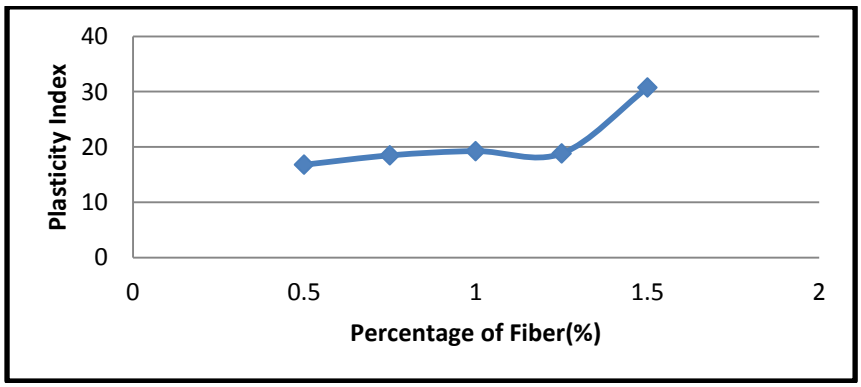

Figure5. Plasticity index Vs. Percentage fibre

From the above results, it can be inferred that, the strength of black cotton soil increases considerably and then decreases when fibre is added in increasing percentages. Therefore for 6mm

fibre, the strength of black cotton soil increases considerably when the percentage of fibre added is 1%.

- **12mm Fibre**

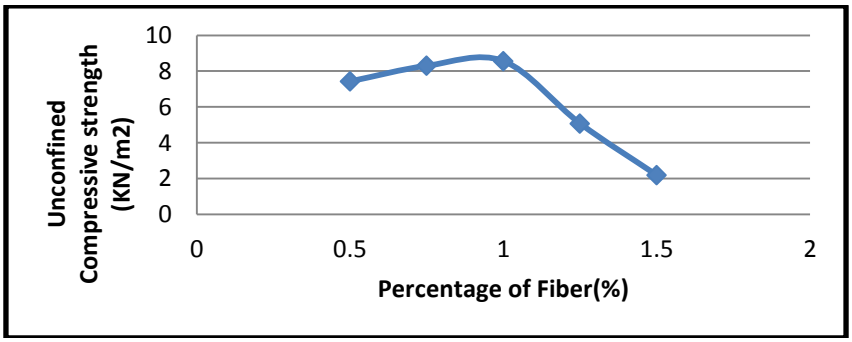

Figure6. Unconfined Compressive strength Vs. Percentage fibre

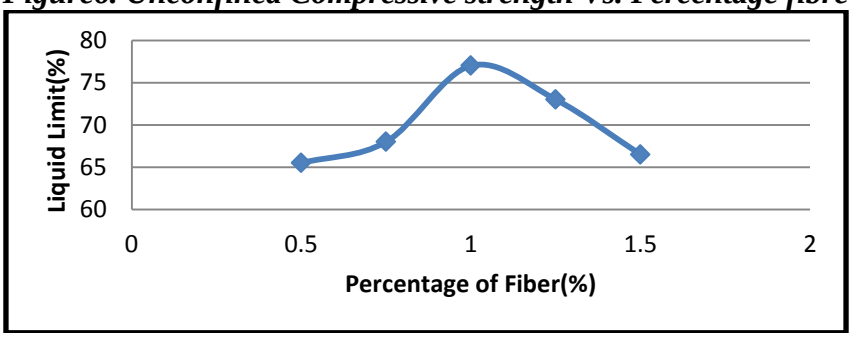

Figure7. Liquid Limit Vs. Percentage fibre

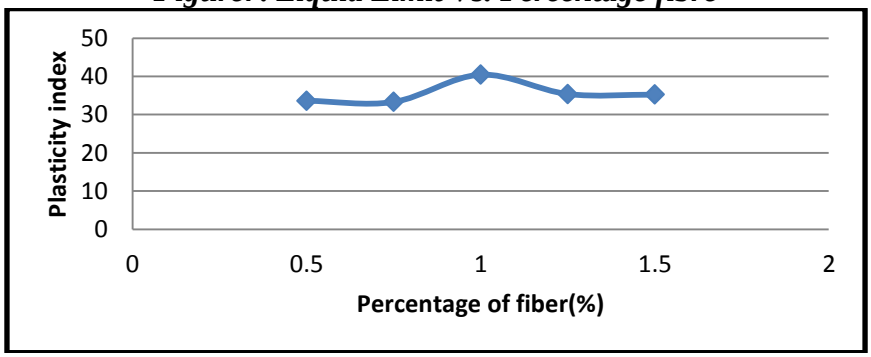

Figure8. Plasticity Index Vs. Percentage fibre

From the above results, it can be inferred that, the strength of black cotton soil increases considerably and then decreases when fibre is added in increasing percentages. Therefore for 12mm fibre, the strength of black cotton soil increases considerably when the percentage of fibre added is 1%.

IV. INFERENCE

- **Comparison Of 6mm And 12mm Fibre For Ucs And Liquid Limit**

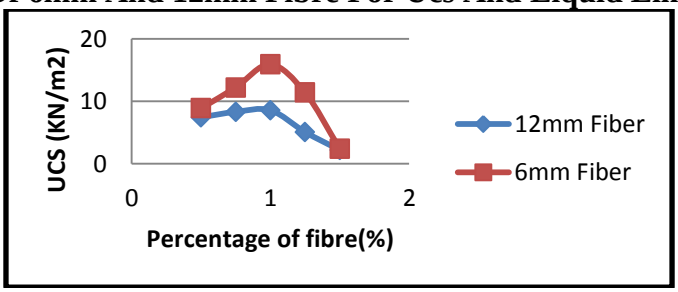

Figure9. UCS Vs Percentage Of Fibre

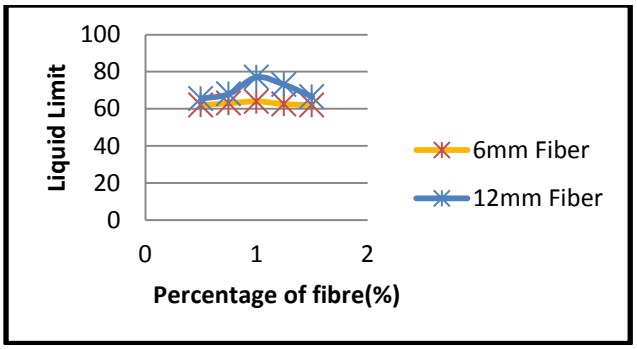

Figure10. Liquid Limit Vs Percentage Of Fibre

Using 6 Mm Fibre

It can be inferred that, the UCS & LL of black cotton soil increases considerably till 1% and then decreases when fibre is added in increasing percentages**.**

Using 12 Mm Fibre

It can be inferred that, the UCS & LL of black cotton soil increases considerably till 1% and then decreases when fibre is added in increasing percentages.

V. CONCLUSION

From the results and discussions, effectiveness of PP fiber in improving the engineering properties of black cotton soil were studied. The effect of polypropylene fibre on improving the strength of black cotton soil was found. Comparison of the properties of soil before and after the addition of fibre was made.

The unconfined compressive strength of treated soil increases with increase in the percentage of polypropylene fibre and reached an optimum value which is 1.3 times for 12mm fibre and 2.42 times for 6mm fibre than that of the plain soil. The optimum percentage of PP fiber is obtained as 1 % for both 6mm fiber and 12mm fibre . It was inferred that 6mm fibre was more effective in improving the soil strength than 12mm fibre..With the addition of fibre the bearing capacity of soil is improved and thereby, the foundation design is made cost effective. By settlement analysis it was found that settlement is less for soil with optimum fibre content than plain soil. The rate of consolidation for soil with optimum fibre content is 4.23 times more than that of plain soil.

REFERENCES

[1] Abhinav Nangia, Sudhir Nigam, Dharmendra Kumar, Shailendra Tiwari, “Effect of Polypropylene Fibre on the Strength Characteristics of the Soils along the Yamuna River Bank in Delhi City”.

[2] Ayyappan S., Hemalatha K. and Sundaram M., June [2010], “Investigation of Engineering Behavior of Soil, Polypropylene Fibers and Fly Ash -Mixtures for Road Construction”.

[3] Bowles J.E., 1996, “Foundation Analysis and Design”, 5th Edition, McGraw Hill Pub. Co. New York.

[4] Mona Malekzadeh, Huriye Bilsel, 2012, “Effect of Polypropylene Fiber on Mechanical Behaviour of Expansive Soils”.

[5] Phani Kumar. V, Naga Bharath C.H., Ganga D., Swathi Priyadarsini P., January 2015, “Experimental Investigation on California Bearing Ratio (CBR) For Stabilizing Silty Sand with Fly Ash and Waste Polypropylene”.

