AN EXPERIMENTAL STUDY ON STABILIZATION OF BLACK COTTON SOIL USING POLYPROPYLENE FIBER

[1]S.Naveen, [2]B.Satyanarayana, [3] G.Venkata Rao, [4]A.Manikanta
[1]Assistant Professor, [2]professor, [3]professor, [4]Assistant Professor
[1]Department of Civil Engineering,
[1]VignanIIT, Vishakhapatnam, India.

Abstract : Soil stabilization is the process of improving the engineering properties of the soil and thus making it more Stable. It is required when the soil available for construction is not suitable for the intended purpose. Black cotton soils are boon to the formers and also problematic to civil engineers. Civil Engineering Structures experience large scale of damage due to change in properties of the soil. In India, these soils occupy around 20% of the total area. A chemical is added to a natural soil for the purpose of stabilization. Soil stabilization is used to reduce the compressibility of the soil mass in earth structures and to increase its shear strength. The main objective of this study is to investigate the use of polypropylene fiber material in geotechnical applications and to evaluate the effects of polypropylene fibers on shear strength of unsaturated soil by carrying out unconfined compression tests on different soil samples. The optimum proportion of polypropylene fiber that improves plasticity characteristics, compaction characteristics and strength characteristics of soil is 0.20%.

IndexTerms **- compaction, MDD, OMC, polypropylene fiber, Soil stabilization, UCS.**

I. INTRODUCTION

From the beginning of construction work, the necessity of enhancing soil properties has come to the light Ancient civilizations of the Chinese, Romans and Incas utilized various methods to improve soil strength etc., some of these methods were so effective that their buildings and roads still exist. The concept of reinforcing soil with natural fiber materials originated in ancient times [2].In India, the modern era of soil stabilization began in early 1970's, with a general shortage of petroleum and aggregates, it became necessary for the engineers to look at means to improve soil other than replacing the poor soil at the building site. Soil stabilization was used but due to the use of obsolete methods and also due to the absence of proper technique, soil stabilization lost favour. In recent times, with the increase in the demand for infrastructure, raw materials and fuel, soil stabilization has started to take a new shape. With the availability of better research, materials and equipment, it is emerging as a popular and cost-effective method for soil improvement. Here, in this project, soil stabilization has been done with the help of randomly distributed polypropylene fibers obtained from waste materials. The improvement in the shear strength parameters has been stressed upon and comparative studies have been carried out using different methods of shear resistance measurement.

II. RESARCH AND METODOLOGY

Materials used

2.1 Black Cotton Soil

Soil stabilization is carried out for weak soils having low strength and poor engineering properties,

Table 1: physical properties of black cotton soil

TESTS	PROPERTIES
Specific gravity	2.59
Liquid limit (%)	82
Plastic limit (%)	38
Plasticity index (%)	44
Sand (%)	32

Silt and clay (%)	68
Maximum dry density (kN/m^3)	13.2
OMC(%)	21

2.2 polypropylene fibers

Most of the researches carried out on fiber reinforcement of soils have made use of polypropylene fibers .this is the most commonly used synthetic material mainly because of its low cost and the ease with which it mixes with soils[4].

Table 2 : physical properties of polypropylene fiber

Fiber type	Single fiber
Unit weight	0.91g/cm^3
Average diameter	0.034mm
Average length	12mm
Breaking tensile strength	350MPa
Modulus of elasticity	3500MPa
Fusion point	165^{0}C
Burning point	590^{0}C
Acid and alkali resistance	Very good
Dispersibility	Excellent

III. OBJECTIVES OF STUDY

In this present study, the objective is to study the geotechnical properties of black cotton soil stabilized with polypropylene. This study is limited to use of polypropylene up to a percent of 0.25 by weight of soil. The experimental work is limited to determine the compaction characteristics and unconfined compressive strength.

IV. RESULTS AND DISCUSSIONS

Fibre is mixed in various percentage of 0.05,0.10,0.15,0.20,0.25 with black cotton soil[3]. Laboratory tests were conducted on Black cotton soil and stabilized soil such as show in below

- Standard proctor compaction test
- Unconfined compression strength
- Atterberg's limits

4.1. Standard proctor compaction test

Compaction tests were conducted on the different fibers mixes on black cotton soil of varying percentage and evaluated to the maximum dry density (MDD) values and optimum moisture content (OMC) values. The OMC decreases with increase in fiber content[1].

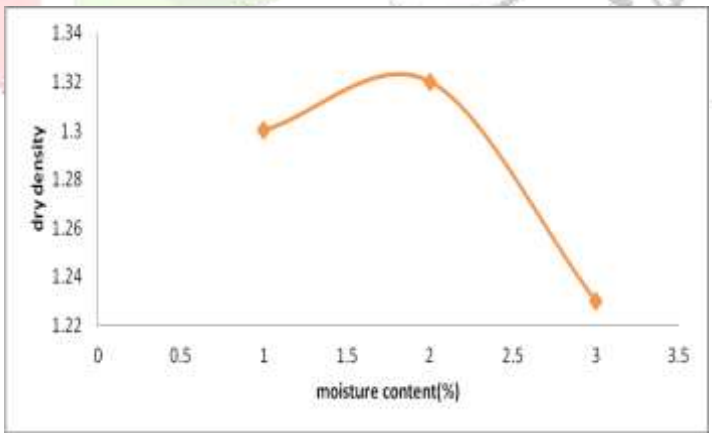

Fig.1 compaction curve for black cotton soil

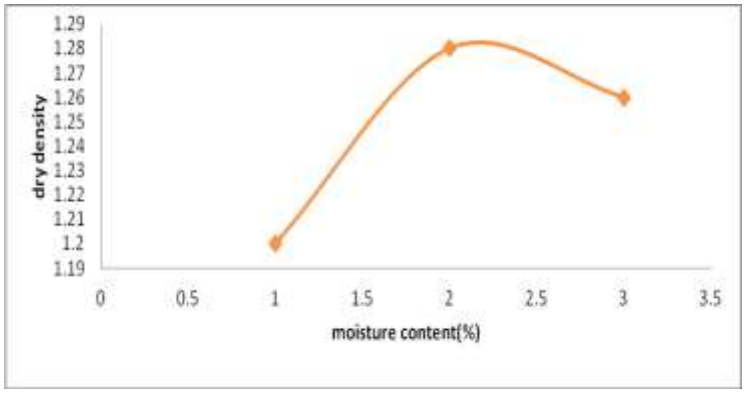

Fig.2 compaction Curve for black cotton soil mixed with 0.05% polypropylene fiber

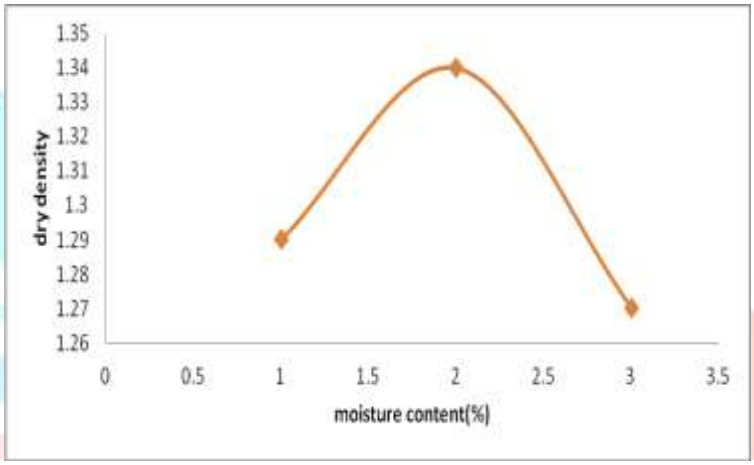

Fig.3 Compaction Curve for black cotton soil mixed with 0.10% polypropylene fiber

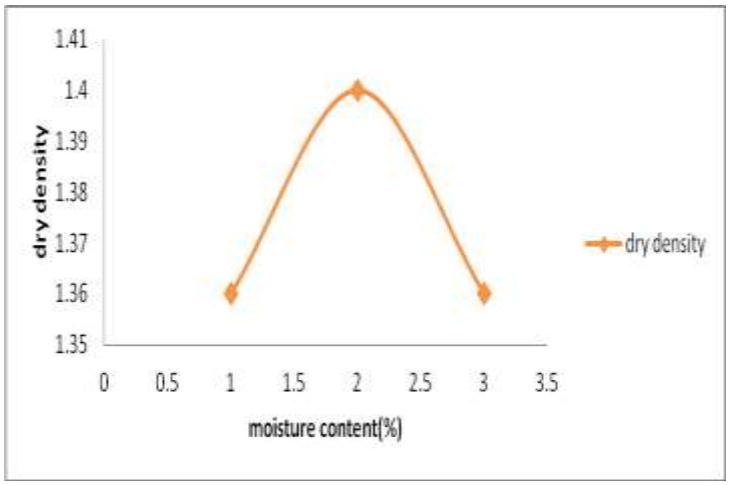

Fig.4 Compaction Curve for black cotton soil mixed with 0.15% polypropylene fiber

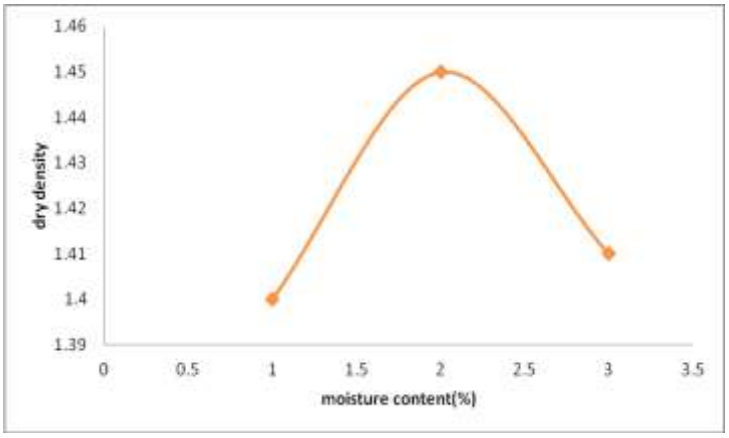

Fig.5 Compaction Curve for black cotton soil mixed with 0.20% polypropylene fiber

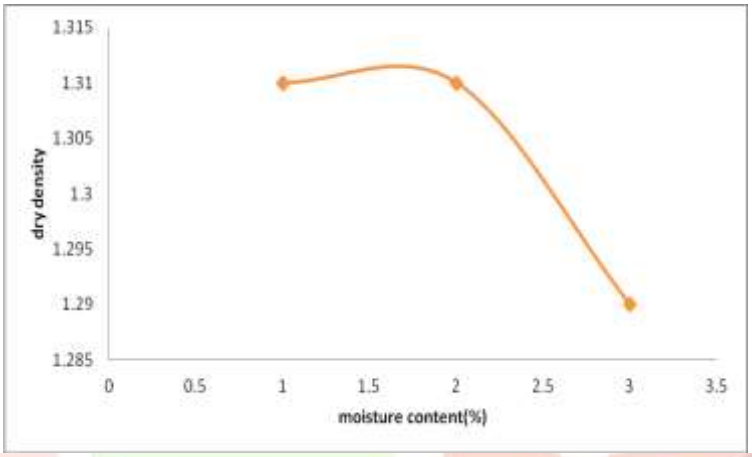

Fig.6 Compaction Curve for black cotton soil mixed with 0.25% polypropylene fiber

4.2 Unconfined compression strength

The UCS tests were conducted on the fiber mixes on black cotton soil samples. It is noted that UCS value of the fibers in various proportions has increased gradually from 1.44kg/cm^2 to 3.59kg/cm^2.The shear strength of the soil is improved due to addition of the fibers[1].

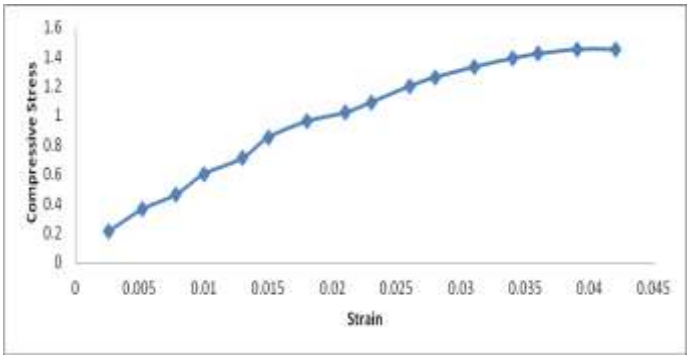

Fig.7 Unconfined Compression for black cotton soil

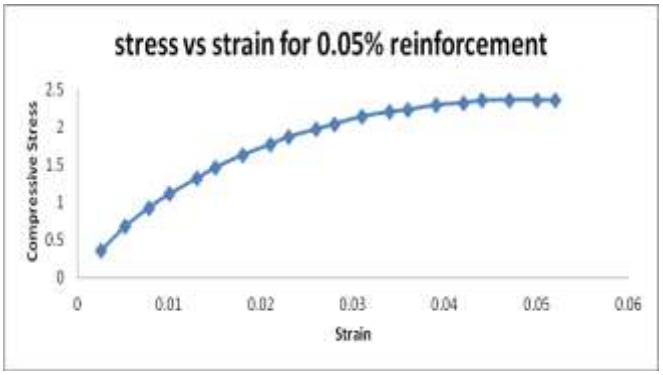

Fig.8 Unconfined Compression for black cotton soil mixed with 0.05% polypropylene fiber

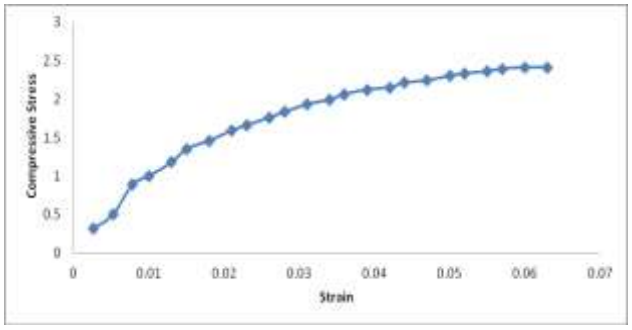

Fig.9 Unconfined Compression for black cotton soil mixed with 0.10% polypropylene fiber

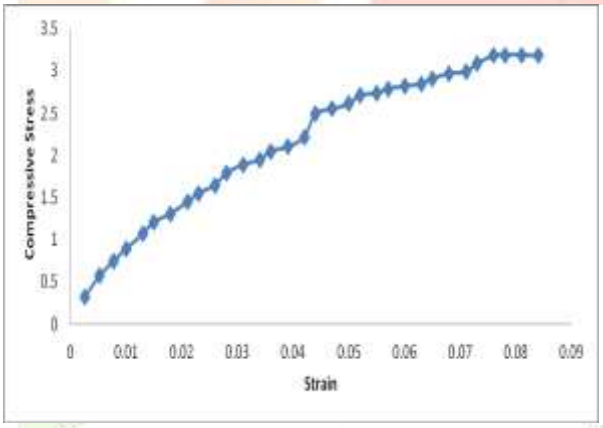

Fig.10 Unconfined Compression for black cotton soil mixed with 0.15% polypropylene fiber

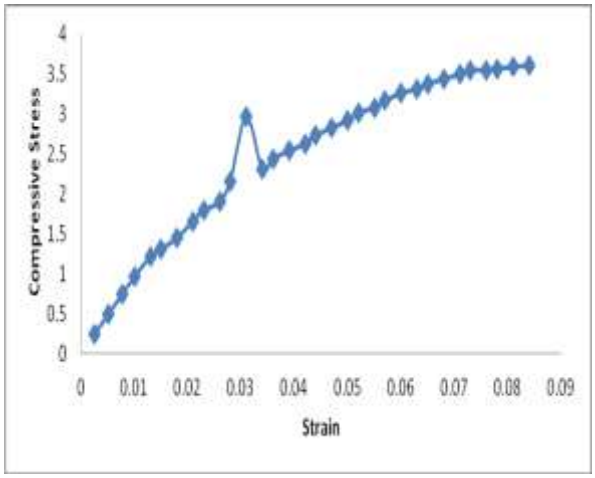

Fig.11 Unconfined Compression for black cotton soil mixed with 0.20% polypropylene fiber

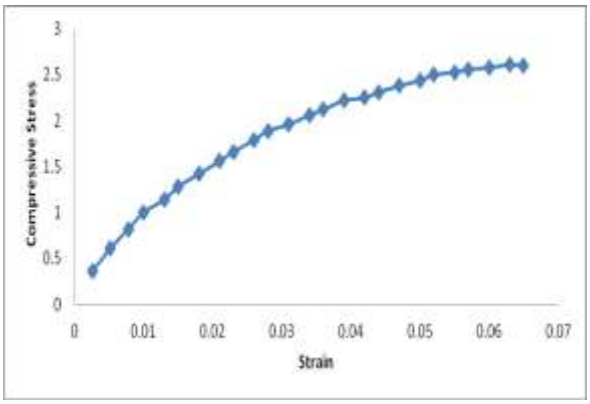

Fig.12 Unconfined Compression for black cotton soil mixed with 0.25% polypropylene fiber

Table 1: The test results of treated and untreated soil

Materials	OMC (%)	MDD (g/cc)	UCC (kg/cm^2)	Shear strength (kg/cm^2)	Liquid limit (%)
Black cotton soil (100%)	21%	1.32	1.44	0.72	82
Soil + 0.05% fibers	20.5%	1.33	2.35	1.175	78
Soil + 0.10% fibers	20%	1.34	2.41	1.205	70
Soil + 0.15% fibers	20%	1.40	3.18	1.59	60
Soil + 0.20% fibers	20%	1.45	3.59	1.795	40
Soil + 0.25% fibers	19%	1.31	2.6	1.30	35

The optimum proportion of polypropylene fiber that improves plasticity characteristics, compaction characteristics and strength characteristics of soil is 0.20%.

V. CONCLUSIONS

Based on the experimental work carried out in the laboratory, the following conclusions were drawn.

The clayey soil under the study is high plastic with a liquid limit of 82%

The maximum dry density of soil is increases and optimum water content decreases with the addition of polypropylene fiber and 0.020% of polypropylene fiber is the optimum content to improve the compaction characteristics

The unconfined compressive strength is increasing with the increase in polypropylene fiber content. The maximum UCC value is 3.59 kg/cm^2.

The shear strength is increasing with the increase in polypropylene fiber content. The maximum shear strength value is 1.795 kg/cm^2.

The UCC values and shear strength values are increasing with the addition of polypropylene fiber content up to 0.20% and decreasing with the further addition of polypropylene fiber content.

The optimum proportion of polypropylene fiber which improves plasticity characteristics, compaction characteristics and strength characteristics of black cotton soil is 0.20% .

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