Soil Stabilization by Using Polypropylene Fiber

Sulabh Bagde[1] , Vaibhav Borkar[2] , Swapnil Bardekar[3],Saili Wankhede[4]

BE CIVIL ENGG. DEPT T.G.P.C.E.T. NGP

rockstarsulabh@gmail.com[1] vaibhavrocker93@gmail.com[2] swapnilbardekar@gmail.com 3
wankhede.saili@gmail.com[4]

1

Abstract-The main objective of this study is to investigate the use of waste fiber materials in geotechnical applications and to evaluate the effects of waste polypropylene fibers on shear strength of unsaturated soil by carrying out direct shear tests and unconfined compression tests on two different soil samples. The results obtained are compared for the two samples and inferences are drawn towards the usability and effectiveness of fiber reinforcement as a replacement for deep foundation or raft foundation, as a cost effective approach.

Keywords*:* Fiber Reinforced Soil ,Black Cotton Soils, Polypropylene fiber,California Bearing Ratio,Unconfined Compressive Strength

I. INTRODUCTION

For any land-based structure, the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. So, to work with soils, we need to have proper knowledge about their properties and factors which affect their behavior. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work.

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. 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 favor. 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.

II.NEEDS & ADVANTAGES

Soil properties vary a great deal and construction of structures depends a lot on the bearing capacity of the soil, hence, we need to stabilize the soil which makes it easier to predict the load bearing capacity of the soil and even improve the load bearing capacity. The gradation of the soil is also a very important property to keep in mind while working with soils. The soils may be well-graded which is desirable as it has less number of voids or uniformly graded which though sounds stable but has more voids. Thus, it is better to mix different types of soils together to improve the soil strength properties. It is very expensive to replace the inferior soil entirely soil and hence, soil stabilization is the thing to look for in these cases.

- It improves the strength of the soil, thus, increasing the soil bearing capacity.
- It is more economical both in terms of cost and energy to increase the bearing capacity of the soil rather than going for deep foundation or raft foundation.
- It is also used to provide more stability to the soil in slopes or other such places.
-
- Sometimes soil stabilization is also used to prevent soil erosion or formation of dust, which is very useful especially in dry and arid weather.
- Stabilization is also done for soil water-proofing; this prevents water from entering into the soil and hence helps the soil from losing its strength.
- It helps in reducing the soil volume change due to change in temperature or moisture content.
- Stabilization improves the workability and the durability of the soil.

III. MATERIALS

Soil sample-1

Location: AMRAVATI, MAHARASHTRA, INDIA (165 km. NAGPUR)

Soil sample- 2

Location: AKOLA, MAHARASHTRA, INDIA (257 km. NAGPUR)

POLYPROPYLENE FIBER

From the Bajaj steels MIDC Nagpur we take Polypropylene fiber

Steps Involved:

Specific gravity of soil

2. Determination of soil index properties (Atterberg Limits)

i) Liquid limit by Casagrande’s apparatus

ii) Plastic limit

3. Particle size distribution by sieve analysis

4. Determination of the maximum dry density (MDD) and the corresponding optimum moisture content (OMC) of the soil by Proctor compaction test

5. Preparation of reinforced soil samples.

6. Determination of the shear strength by:

i) Direct shear test (DST)

ii) Unconfined compression test(UCS)

Fig. Polypropylene fiber

Index and strength parameters of PP-fiber

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

IV. RESULTS AND DISCUSSIONS

I. Comparison between soil sample-1 and soil sample- 2 for specific gravity

Soil sample 1

Sample number	1	2	3

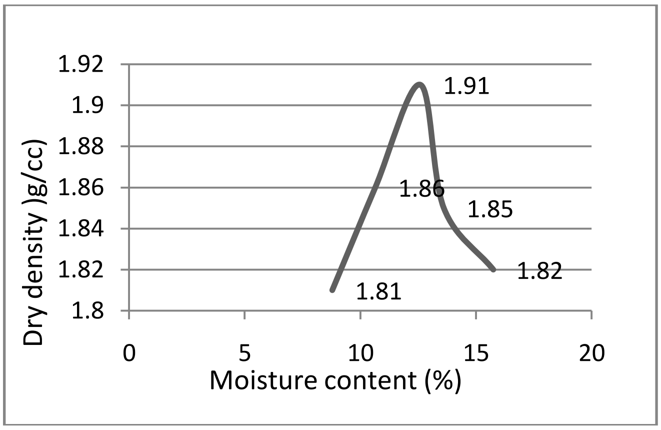
Mass of empty bottle (M1) in gms	670	620	660
Mass of bottle+ dry soil (M2) in gms	860	840	880
Mass of bottle + dry soil + water (M3) in gms	1650	1630	1670
Mass of bottle + water (M4) in gms	1540	1470	1550
Specific gravity	2.37	3.67	2.2
Avg. specific gravity	2.74		

Soil sample-2

Sample number	1	2	3
Mass of empty bottle (M1) in gms	670	620	660
Mass of bottle+ dry soil (M2) in gms	890	850	880
Mass of bottle + dry soil + water (M3) in gms	1670	1620	1660
Mass of bottle + water (M4) in gms	1550	1510	1550
Specific gravity	2.7	2.5	2.6
Avg. specific gravity	2.6		

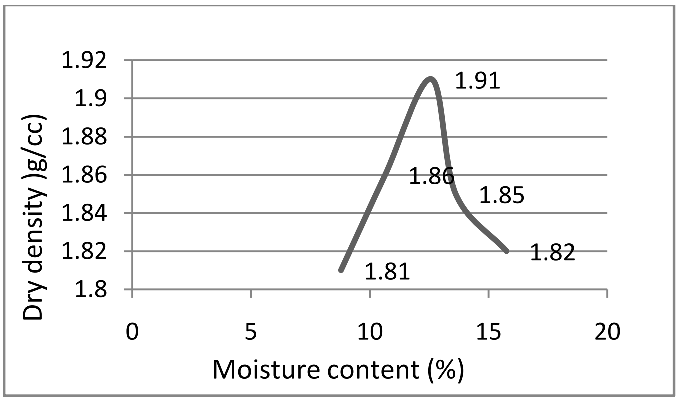
II. Standard Proctor Compaction Test

Soil sample 1



From the figure on the left side, it is evident that,
Optimum Moisture Content (OMC) = 12.6%
Maximum Dry Density (MDD) = 1.91 g/cc

Soil sample-2



From the figure on the left side, it is evident that,
Optimum Moisture Content (OMC) = 17.02%
Maximum Dry Density (MDD) = 1.96 g/cc

III. Comparison of shear parameters between soil sample- 1 and soil sample- 2

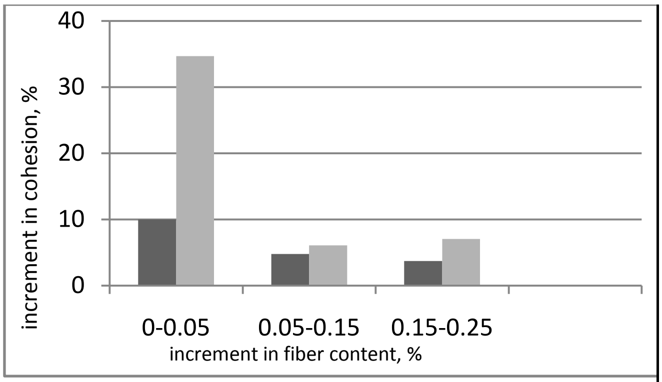


Fig 4.1

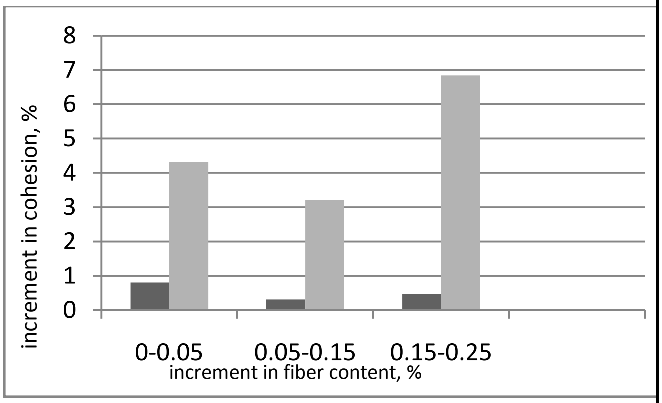


Fig 4.2

IV. Comparison between soil sample-1 and soil sample- 2 for UCS

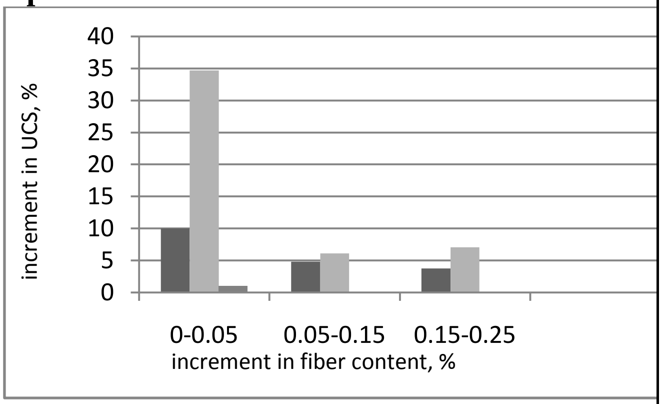


Fig.4.3

V. INFERENCES

I.INFERENCES FROM DIRECT SHEAR TEST

Soil sample- 1

Cohesion value increases from 0.325 kg/cm2 to 0.3887 kg/cm2, a net **19.6%**

The angle of internal friction increases from 47.72 to 48.483 degrees, a net **1.59%**

The increment in shear strength of soil due to reinforcement is **marginal**.

Soil sample- 2

Cohesion value increases from 0.3513 kg/cm2 to 0.5375 kg/cm2, a net **53.0%**

The angle of internal friction increases from 27.82 to 32 degrees, a net **15.02%**

The increment in shear strength of soil due to reinforcement is **substantial**.

II.INFERENCES FROM UNCONFINED COMPRESSION TEST

Soil sample- 1

UCS value increases from 0.0643 MPa to 0.0562 MPa, a net **14.4%**

Soil sample- 2

UCS value increases from 0.0692 MPa to 0.1037 MPa, a net **49.8%**

VI. CONCLUSION

Overall it can be concluded that fiber reinforced soil can be considered to be good ground improvement technique specially in engineering projects on weak soils where it can act as a substitute to deep/raft foundations, reducing the cost as well as energy.

REFERENCE

[1] S. A. Naeini and S. M. Sadjadi ,(2008) ," Effect of Waste Polymer Materials on Shear Strength of Unsaturated Clays", EJGE Journal, Vol 13, Bund k,(1-12).

[2]Yetimoglu, T., Inanir, M., Inanir, O.E., 2005. A study on bearing capacity of randomly distributed

fiber-reinforced sand fills overlying soft clay. Geotextiles and Geomembranes 23 (2), 174–183.

[3] Chaosheng Tang, Bin Shi, Wei Gao, Fengjun Chen, Yi Cai, 2006. Strength and mechanical behavior of short polypropylene fiber reinforced and cement stabilized clayey soil. Geotextiles and Geomembranes 25 (2007) 194–202.

[4] Mahmood R. Abdi, Ali Parsapajouh, and Mohammad A. Arjomand,(2008)," Effects of Random Fiber Inclusion on Consolidation, Hydraulic Conductivity, Swelling, Shrinkage Limit and Desiccation Cracking of Clays", International Journal of Civil Engineering, Vol. 6, No. 4, (284-292).

[5] Consoli, N. C., Prietto, P. D. M. and Ulbrich, L. A. (1999). ‘‘The behavior of a fibre-reinforced cemented soil.’’ Ground Improvement, London, 3(1), 21–30.

[6] IS 2720 – part (xiii) 1980-87

[7] The need for soil stabilization, April 9, 2011 by Ana [online] Available at: < http://www.contracostalandscaping.com/the-need-for-soil-stabilization/>

[8]Methods of soil stabilization, December 24, 2010 [online] Available at: < http://www.engineeringtraining.tpub.com/14070/css/14070_424.htm >

[9]Prof. Krishna Reddy, UIC, 2008, Engineering Properties of Soils Based on Laboratory Testing.