Satyam Tiwari* et al.
(IJITR) INTERNATIONAL JOURNAL OF INNOVATIVE TECHNOLOGY AND RESEARCH
Volume No.4, Issue No.3, April – May 2016, 2927 – 2930.

# Soil Stabilization Using Waste Fiber Materials

**SATYAM TIWARI**
Research Scholar
Department of Civil Engineering
Acropolis institute of Technology & Research
Bhopal

**NISHEET TIWARI**
Assistant Professor
Department of Civil Engineering
MANIT, Bhopal

*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**

## 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. 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. EXPERIMENTAL INVESTIGATION

### *Scope of Work*

The experimental work consists of the following step

- Specific gravity of soil
- Determination of soil index properties (Atterberg Limits)
- Liquid limit by Casagrande's apparatus
- Plastic limit
- Particle size distribution by sieve analysis
- Determination of the maximum dry density (MDD) and the corresponding optimum moisture content (OMC) of the soil by Proctor compaction test
- Preparation of reinforced soil samples.
- Determination of the shear strength by:
  Direct shear test (DST)
  Unconfined compression test (UCS).

### *Materials*

I. Soil sample-1

II. Reinforcement: Short PP (polypropylene) fiber.

***Figure No 1 POLYPROPYLENE***

***Table No. 1 Index and strength parameters of PPF***

| **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$^0$C |
| Burning point | 590$^0$C |
| Acid and alkali resistance | Very good |
| Dispersibility | Excellent |

  

***Preparation Of Samples***

Following steps are carried out while mixing the fiber to the soil-

i) All the soil samples are compacted at their respective Maximum Dry Density (MDD) and optimum moisture content (OMC),corresponding to the standard proctor compaction tests

ii) Content of fiber in the soils are herein decided by the following equations

Where, ρf= ratio of fiber content

Wf = weight of the fiber

W = Weight of the air-dried soil

iii) The different values adopted in the present study for the percentage of fiber reinforcement are 0, 0.05, 0.15, and 0.25

iv) In the preparation of samples, if fiber is not used then, the air-dried soil was mixed with an amount of water that depends on the OMC of the soil If fiber reinforcement was used, the adopted content of fibers was first mixed into the air-dried soil in small increments by hand, making sure that all the fibers were mixed thoroughly, so that a fairly homogenous mixture is obtained, and then the required water was added.

***Brief Steps Involved In The Experiments***

**Specific gravity of the soil** The specific gravity of soil is the ratio between the weight of the soil solids and weight of equal volume of water. It is measured by the help of a volumetric flask in a very simple experimental setup where the volume of the soil is found out and its weight is divided by the weight of equal volume of water W1- Weight of bottle in gms W2 –weight of bottle + Dry Soil in gms. W3-weight of bottle + Soil + Water. W4 - Weight of bottle + Water Specific gravity is always measured in room temperature and reported to the nearest 0.1

**Liquid limit** The Casagrande's tool cuts a groove of size 2mm wide at the bottom and 11 mm wide at the top and 8 mm high. The number of blows used for the two soil samples to come in contact is noted down. Graph is plotted taking number of blows on a logarithmic scale on the abscissa and water content on the ordinate. Liquid limit corresponds to 25 blows from

**Plastic limit** This is determined by rolling out soil till its diameter reaches approximately 3 mm and measuring water content for the soil, which crumbles on reaching this diameter.

Plasticity index (Ip) was also calculated with the help of liquid limit and plastic limit;

$Ip = wL – wP$

WL-Liquid limit WP- Plastic limit

**Particle size distribution** The results from sieve analysis of the soil when plotted on a semi-log graph with particle diameter or the sieve size as the abscissa with logarithmic axis and the percentage passing as the ordinate gives a clear idea about the particle size distribution. From the help of this curve, D10 and D60 are determined. This D10 is the diameter of the soil below which 10% of the soil particles lie. The ratio of, D10 and D60 gives the uniformity coefficient (Cu), which in turn is a measure of the particle size, range. 2.4.5 Proctor compaction test

This experiment gives a clear relationship between the dry density of the soil and the moisture content of the soil. The experimental setup consists of (i) cylindrical metal mold (internal diameter- 10.15 cm and internal height-11.7 cm), (ii) detachable base plate, (iii) collar (5 cm effective height), (iv) rammer (2.5 kg). Compaction process helps in increasing the bulk density by driving out the air from the voids. The theory used in the experiment is that for any compactive effort, the dry density depends upon the moisture content in the soil. The maximum dry density (MDD) is achieved when the soil is compacted at relatively high moisture content and almost all the air is driven out, this moisture content is called optimum moisture content (OMC). After plotting the data from the experiment with water content as the abscissa and dry density as the ordinate, we can obtain the OMC and MDD. The equations used in this Experiment is as follows 2.4.6 Direct shear test This test is used to find out the cohesion (c) and the angle of internal friction (φ) of the soil, these are the soil shear strength parameters. The shear strength is one of the most important soil properties and it is required whenever any structure depends on the soil shearing resistance. The test is conducted by putting the soil at OMC and MDD inside the shear box, which is made up of two independent parts. A constant normal load (σ) is applied to obtain one value of c and φ. Horizontal load (shearing load) is increased at a constant rate and is applied till the failure point is reached. This load when divided with the area gives the shear strength 'τ' for that particular normal load. The equation goes as follows: $\tau = c + \varsigma * \tan(\varphi)$ After repeating the experiment for different normal loads (σ) we obtain a plot which is a straight line with slope equal to angle of internal friction (φ) and intercept equal to the cohesion (c). Direct shear test is the easiest and the quickest way to determine the shear strength parameters of a soil sample. The preparation of the sample is also very easy in this experiment 3

## III. RESULTS AND DISCUSSION

The tests results are summarized in Table 2. The variation in the Optimum moisture contents, Maximum dry density, California bearing ratio, unconfined compressive strength and Differential free index are shown in Figures 1 to 3.

***Table 2: Summary of Results***

| | Sample 01 | Sample 02 | Sample 03 |
|---|---|---|---|
| Specific Gravity Of Soil Without Fiber | 2.6315 | 2.65 | 2.6842 |
| Specific Gravity Of Soil With Fiber | 2.64 | 2.655 | 2.6895 |
| Liquid Limit Of Soil Without Fiber | 40.33 % | 47.05 % | 45.31 % |
| Liquid Limit Of Soil With Fiber | 43.89 % | 36% | 41.80 % |
| Plastic Limit Of Soil Without Fiber | 28.68 % | 29.67 % | 29.72 % |
| Plastic Limit Of Soil With Fiber | 22.35 % | 28.14 % | 27.03 % |
| Shrinkage Limit Of Soil Without Fiber | 3.029 | 2.97 | 2.94 |
| Shrinkage Limit Of Soil With Fiber (Ppf) | 5.65 | 6.1 | 5.46 |

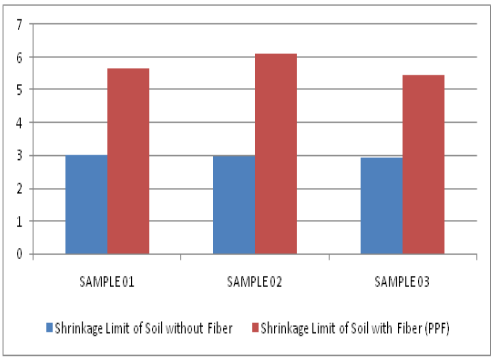


***Figure No 2 Shrinkage Limit***

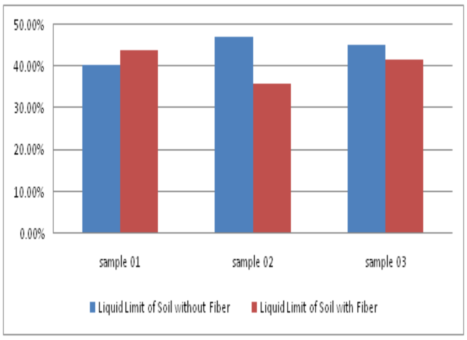


***Figure No 3 Liquid Limit***

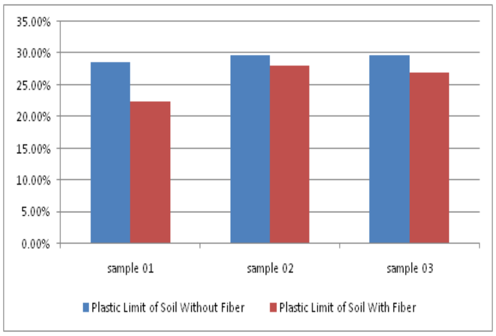


***Figure No 4 Plastic Limit***

## IV. CONCLUSION

[1]. Based on Specific gravity of a soil- With mixing of 0.5% fibers (PPF) specific gravity of the soil increases by 0.3%. (From table no 3 and 4) Strength of the soil is directly proportional to specific gravity, more is the specific gravity more will be the strength of soil.

[2]. Based on liquid limit of a soil - Soil without reinforcement and with reinforcement have liquid limit difference of 18.18%.

[3]. Based on plastic limit of a soil - As similar to liquid limit the plastic limit of soil is also reduces. It reduces from 29.35% to 25.8% . % decrease in plastic limit is 12% (From table no 7 and 8) , This result shows increase in shear strength , Cohesiveness and consistency of soil mass.

[4]. Based on liquid limit of a soil - The value of the shrinkage limit in reinforced soil is less than that of unreinforced soil. Hence with the use of polypropylene fiber shrinkage reduces.

[5]. The value of shrinkage limit is used for understanding the swelling and shrinkage properties of cohesive soil. lesser is the shrinkage more will the suitability of material for foundation , road and embankment as more will be the strength.

## V. REFERENCES

[1]. ASTM D 854 "Standard test methods for specific gravity of soil solids by water pycnometer".

[2]. "Method of Test for Specific Gravity of Soils" published by "Department of Transportation Engineering Service Center, California".

[3]. "Test Method for the Determination of the Specific Gravity of Soils" published by "Geotechnical Engineering Bureau", (April 2007).

[4]. Akbar Pashazadeh1, Mahmood Ghazavi2 , and Morteza Chekaniazar3 presented in there paper entitled "Experimental study of

  

the effect of polyethylene fibers with random distribution on the engineering behavior of the mixture of flimsy sand with clay soils" (2011)

[5]. Behzad Kalantari presented in there paper entitled "Laboratory Investigation on the Effect of Polypropylene Fibers on the CBR of Stabilized Wind-Blow Sand" (2011)

[6]. Shah Kinjala, A.K.Desaib and C.H.Solankic presented in there paper entitled "Experimental Study On The Atterberg Limit's Of Expansive Soil Reinforced With Polyester Triangular Fibers" published in "International Journal of Engineering Research and Applications" (IJERA) Vol. 2, Issue 4, June-July 2012, pp.636-639.

[7]. Rabindra Kumar Kar, Pradip Kumar Pradhan, Ashutosh Naik presented in there paper entitled "Consolidation Characteristics of Fiber Reinforced Cohesive Soil" (2012).

[8]. G.S. Ghataora and U.K. Ling presented in there paper entitled "Behaviour of Fibre-Reinforced And Stabilized Clayey Soils Subjected To Cyclic Loading" published in "Studia Geotechnica et Mechanica", Vol. XXXII, No. 3, 2010.

[9]. Krishna R. Reddy address on "Engineering Properties of Soils Based on Laboratory Testing". (August 2002)

[10]. Gopal Ranjan, A.S.R.Rao, 1991 "Basic and Applied Soil Mechanics"

[11]. Strength and mechanical behavior of short polypropylene fiber reinforced and cement stabilized clayey soil published by Chaosheng Tang Bin Shi Wei Gao Fengjun Chen Yi Cai.

[12]. Dr. K.R. ARORA, "Soil Mechanics and Foundation Engineering", 2008.

[13]. B.C. PUNMIA, 2007, "Soil Mechanics and Foundation", Laxmi Publications

  