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UTILIZATION OF WASTEFIBER MATERIALS FOR SOIL STABILIZATION

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ABSTRACT: *The objective of this paper is to upgrade Clayey Soil with Low Compressibilityas a construction material using waste fiber materials.There is a gradual increase in generation of waste fiber all around the world due to Changing Consumption, Population Growth, and Production Patterns.The amount of waste areincreasing year by year and the disposal becomes a seriousproblem. In Asia and the Pacific and other developing regions, plastic consumption has increased more than the world's average due to rapid urbanization and economic development.After paper waste and food waste, plastic waste is the third major constitute at municipal and industrial waste in cities. Even the cities consist low economic growth have started producing more plastic waste due to increased use ofplastic packaging,plastic shopping bags, , PET bottles and other goods using plastic as the major component. This situation gets worsened due to the ill-effects of plastic waste to environment. Due to long periods required for decomposition, waste fiber is the most visible component in waste dumps and open landfills.This study presents a simple way of recycling plastic waste to stabilize the soil.Plastic waste recycling can provide an opportunity to collect and dispose off plastic waste in the most environmental friendly way and it can be converted into a resource. Due to growing concern about the disposal off plastic waste, and the panic in the current environment, the objective of this paper was chosen as "UTILIZATION OF WASTEFIBER MATERIALS FOR SOIL STABILIZATION" which is one of the type of the fiber waste. In this research work, an*
Extensive works have been done to investigate the use of the waste fibers for the improvement of the various properties of the Clayey (CL) type of soil. The physical properties of the "Plain Soil" and "Reinforced Soil" such as Direct Shear Strength, Unconfined Compressive Strength and Maximum Dry Density at Optimum Moisture Content have been determined with the use of waste fibers materials at different percentage 0 %, 0.05%, 0.15% & 0.25% of waste fiber materials by weight of the dry soil sample.

KEYWORDS: *Soil Stabilization, Fibers of Waste Plastics, Reinforcement, Maximum Dry Density, Optimum Moisture Content, Direct Shear Strength Parameters, Unconfined Compressive Strength*

INTRODUCTION

Soil exhibit generally undesirable engineering properties they tend to have low shear strength and they lose shear strength upon wetting or other physical disturbances. The properties of soil change not only from one place to other but also with depth and with a change in the environmental, loading type, drainage and the conditions under which the soil exists. Waste fiber is successfully used for stabilizing alluvial soil. The following geotechnical design criteria have to be considered during site selection:
i) Bearing capacity of subsoil
ii) Type of foundation to be used.
iii) Design load and function of the structure.
In the recent years, researchers are trying to develop solutions for the reuse ofdifferent wastes generated which has become one of the major challenges for theenvironmental issues in many countries. Shish pal, Vinod Kumar and Jasvir S Rattan described testing carried out on fabric-reinforced and fiber reinforced soil.

The results showed that the increase in the strength of the soil was generally proportional to the amount of reinforcement, but the strength increase eventually reached a limiting value.

SOIL TO BE STABILIZED

Soil: In the present study the soil procured from Ambala City, Haryana (India) has been investigated and depending on the properties, the soil had been classified as Clayey Soil(Cl) with Low Compressibility as shown in Table 1.

Table 1: Determination of Classification of Soil Depending on the Index Properties

Sr. No.	Properties of the Soil Sample	Values of the Different Properties	
		Soil Sample-1	**Soil Sample-2**
1.	Liquid Limit	28.92	43.91
2.	Plastic Limit	22.61	19.64
3.	Plasticity Index (IP)	6.31	24.28
4.	Type of Soil as per IS: 1498 CL	CL	CL
5.	Specific Gravity (G)	2.72	2.62

The various engineering properties of the plain soil have been determined and are shown below

Table 2: Values of Engineering Properties of the Soil

Sr. No.	Engineering Property of the Plain Soil Sample	Observed Value	
		Soil Sample-1	Soil Sample-2
1.	**Compressibility (MDD)** Maximum Dry Density, (ϒd(max)) Optimum Water Content, (*w*)	 1.92 (g/cc) 12.5 (%)	 1.96 (g/cc) 17.01 (%)
2.	**Direct Shear Test (DST)** Angle of Internal Friction (Φ) Cohesion (c)	 48.483° 0.38 (kg/cm^2)	 32° 0.54(kg/cm^2)
3.	**Unconfined Compressive Strength, (UCS)**	0.0648mpa	o.1042 mpa

EXPERIMENTAL INVESTIGATIONS AND RESULTS

Compaction Test: The Standard Proctor Compaction Test have been conducted for the determination of the Optimum Moisture Content **(*w*)** andMaximum Dry Density (Υ_d(max)) of the plain soil are shown in Table-3

Table 3: Data for OMC-MDD of Plain Soil Samples

Sr. No.	Sample No.	Dry Density (g/cc)	Water Content (%)
1.	1	1.92	12.5
2.	2	1.96	17.01

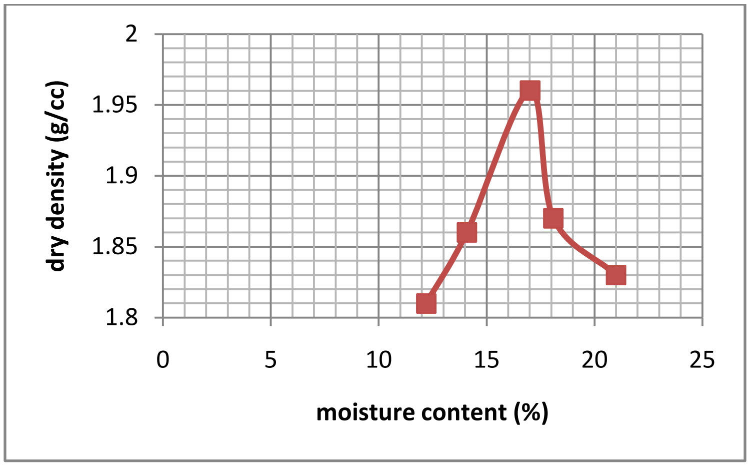

Fig. 1: OMC – MDD Curve for Plain Soil Sample

The maximum dry density of the plain soil has been found as 1.96g/cc at 17.01% of optimum moisture content from thecurve drawn in fig.1 andtabulated given below in Table-3.

DIRECT SHEAR TEST (DST) OF THE SOIL

Table 4: Values of DSTof the Soil

Sr. No.	% of Reinforcement Fiber (%)	Soil Sample-1	Soil Sample-2	Soil Sample-1	Soil Sample-2
		Angle of Internal Friction, Φ		Cohesion, c (kg/cm2)	
1.	0	47.72	27.82	0.325	0.3513
2.	0.05	48.101	29.02	0.3575	0.4732
3.	0.15	48.254	29.95	0.3747	0.504
4.	0.25	48.483	32	0.3887	0.5375

Table 5: Comparison of shear parameters between soil sample- 1 and soil sample- 2

Sr. No.	% of Reinforcement Fiber (%)	Soil Sample1	Soil Sample2	Soil Sample1	Soil Sample2
		Increase in Angle of Internal Friction (Φ)		Increase in Cohesion (c)	
1.	0-0.05	0.8	4.31	4.8	34.7
2.	0.05-0.15	0.32	3.2	3.73	6.51
3.	0.15-0.25	0.47	6.84	10	6.65

The increase in angle of internal friction with the addition of waste fibers of PP has been graphically shown in fig.3 and fig.4

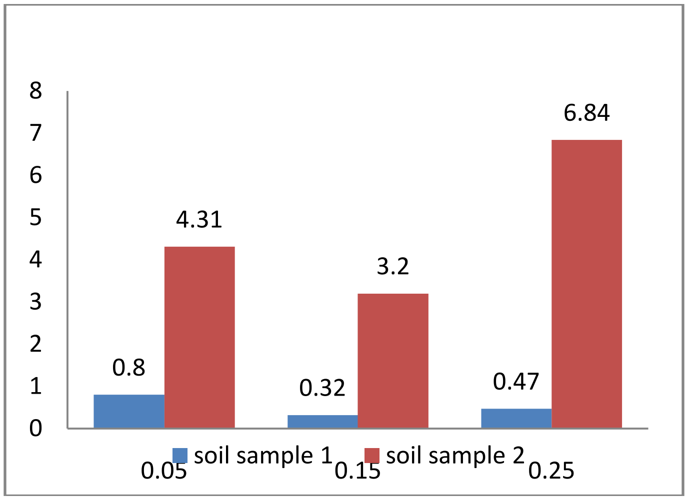

Fig. 2: Increase in Angle of Internal Friction with the Increase in Waste Fibers of PP

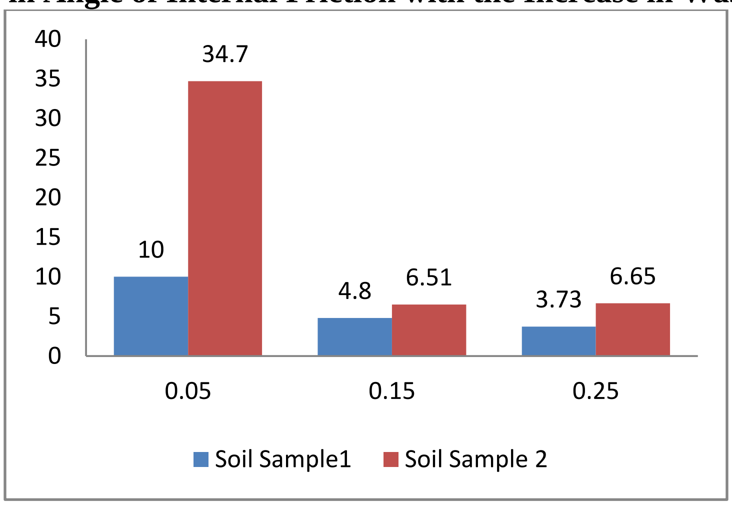

Fig. 3: Increase in Cohesion with the Increase in Waste Fibers of PP
Soil Sample-1

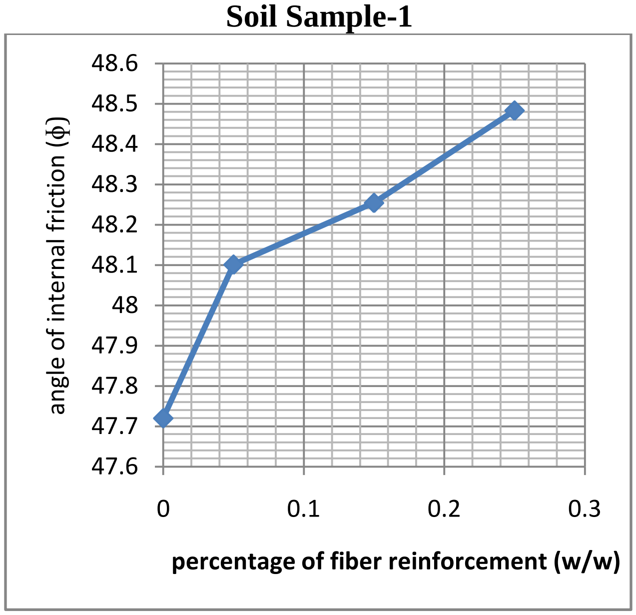

Fig. 4: Increase in Angle of Internal Friction with the Increase in Waste Fibers of PP
Soil Sample-2

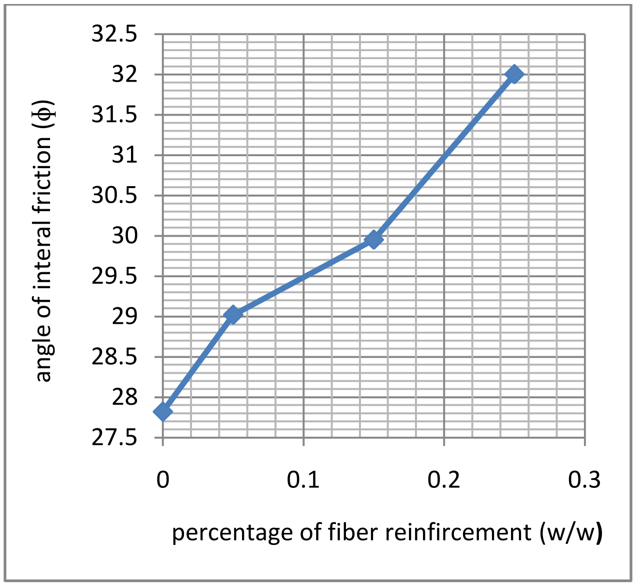

Fig. 5: Increase in Angle of Internal Friction with the Increase in Waste Fibers of PP

The increase in cohesion with the addition of waste fibers of PP has been graphically shown in fig.6 and fig. 7

Soil Sample-1

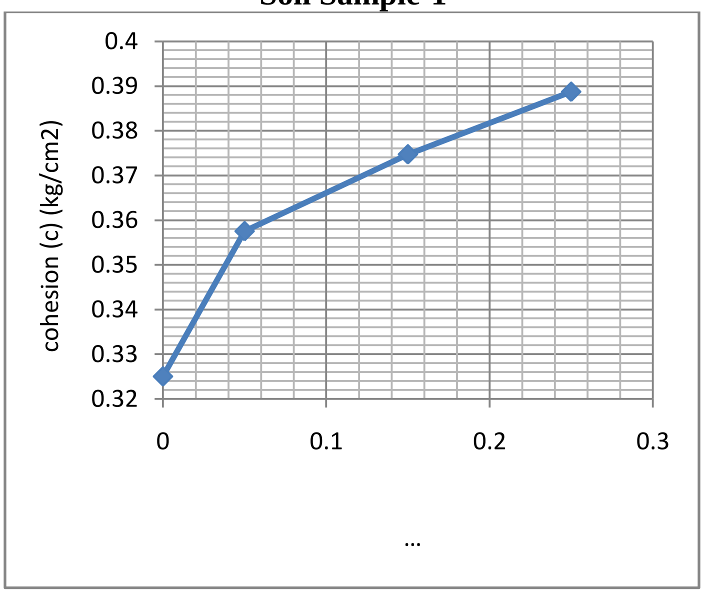

Fig. 6: Increase in Cohesion with the Increase in Waste Fibers of PP

Soil Sample-2

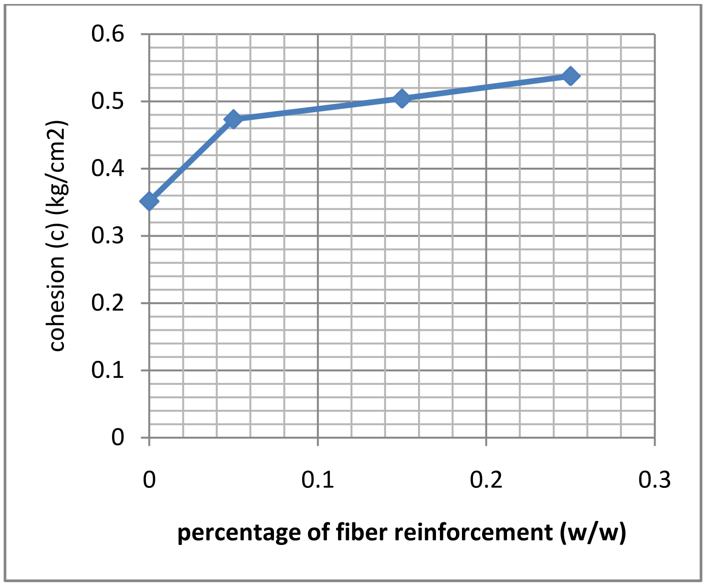

Fig. 7: Increase in Cohesion with the Increase in Waste Fibers of PP

UNCONFINED COMPRESSIVE STRENGTH (UCS) OF THE SOIL

The clayey soil samples of plain soil and reinforced with the fibers of waste polypropylene had been tested by using the unconfined compressive strength test apparatus at the maximum dry density (Υ_d(max)), and optimum moisture content (*w*), for the analysis of the unconfined compressive strength and the results for the same has been tabulated as follows:

Table 6: Values of UCS of the Soil

Sr. No.	Percentage of Reinforcement Fiber (%)	**Soil Sample-1**	**Soil Sample-2**
		UCS of Reinforced Soil, (kg/cm2)	
1.	0	0.0572	0.0694
2.	0.05	0.0636	0.0943
3.	0.15	0.0642	0.0967
4.	0.25	0.0648	0.1042

The comparisons of unconfined compressive strengthof the plain soil with theunconfined compressive strength of the reinforced soil are as follows:

Table 7: Comparisons of Increase in UCS of Reinforced Soil with Plain Soil

Sr. No.	Percentage of Reinforcement Fiber (%)	Soil Sample-1	Soil Sample-2
		Increase in UCS of Soil	
1.	0-0.05	11.19	35.88
2.	0.05--0.15	0.94	2.55
3.	0.15-0.25	0.93	7.76

The increase in UCS of soil with the addition of waste fibres of PP has been graphically shown in fig.8and fig.9

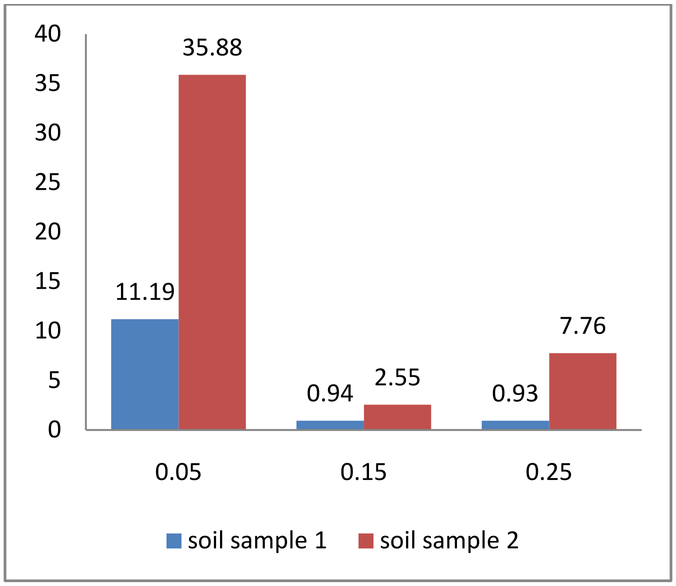

Fig.: Increase in UCS with the Increase in Waste Fibers of PP

Soil Sample-1

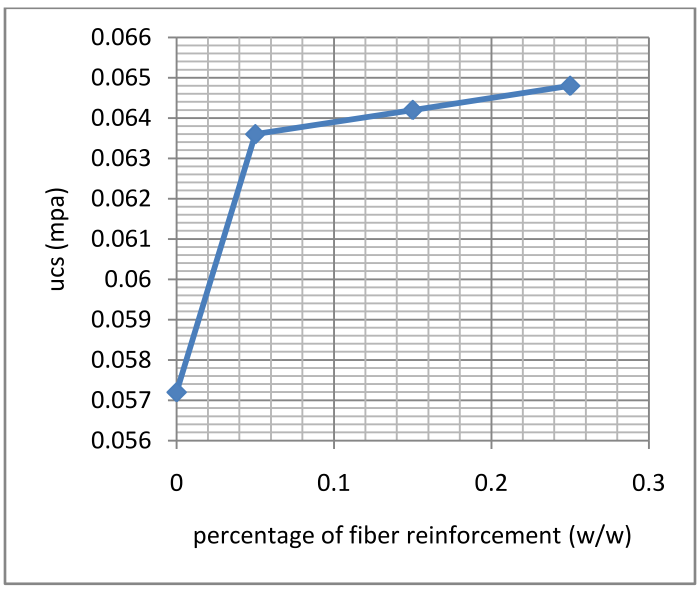

Fig. 8: Incremental Increase in UCS with the Increase in Waste Fibres of PP

Soil Sample-2

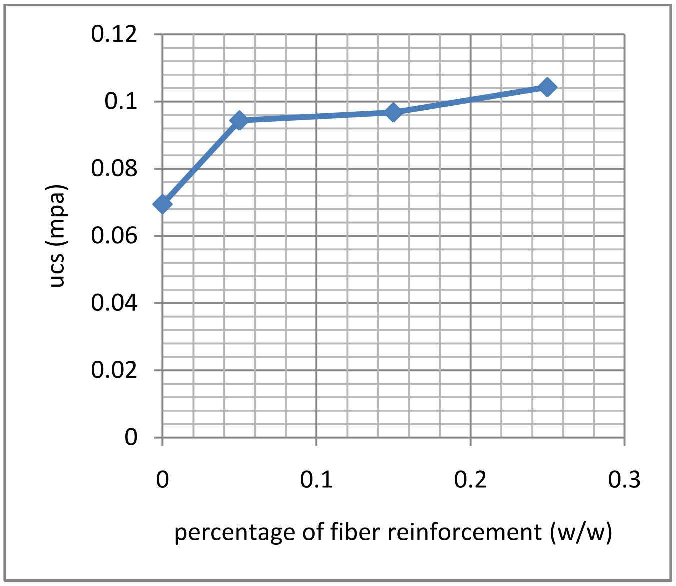

Fig. 9: Incremental Increase in UCS with the Increase in Waste Fibers of PP

CONCLUSIONS OF THE STUDY

On the basis of the analysis and interpretations of the results obtained from the experimental investigations carried outin the present research work, the following conclusions are drawn:

Compressibility of the Soil

In case of the compressibility, it is concluded that there is marginal decrease in the maximum dry density (Υ_d(max)), with the addition of waste fibers of the polypropylene.

Direct Shear Strength of the Soil

- Based on direct shear test on soil sample- 1, with fiber reinforcement of 0.05%, 0.15% and 0.25%, the increase in cohesion was found to be 10%, 4.8% and 3.7% . The increase in the internal angle of friction (φ) was found to be 0.8%, 0.3% and 0. 47% . Since the net increase in the values of c and φ were observed to be 19.6%, from 0.325 kg/cm2 to 0.3887 kg/cm2 and 1.59%, from 47.72 to 48.483 degrees respectively, for such a soil, randomly distributed polypropylene fiber reinforcement is not recommended.
- The shear strength of soil sample- 2 were determined by direct shear test. The increase in the value of cohesion for fiber reinforcement of 0.05%, 0.15% and 0.25% are 34.7%, 6.09% and 7.07% respectively. Figure 27 illustrates that the increase in the internal angle of friction (φ) was found to be 0.8%, 0.31% and 0. 47% respectively. Thus, a net increase in the values of c and φ were observed to be 53%, from 0.3513 kg/cm^2 to 0.5375 kg/cm^2 and 15.02%, from 27.82 to 32 degrees. Therefore, the use of polypropylene fiber as reinforcement for soils like soil sample- 2 is recommended.

Unconfined Compressive Strength (UCS) of the Soil

- The results from the UCS test for soil sample- 1 are also similar, for reinforcements of 0.05%, 0.15% and 0.25%, the increase in unconfined compressive strength from the initial value are 11.19%, 0.94% and 0.93 %
- On comparing the results from UCS test of soil sample- 2, it is found that the values of unconfined compressive strength shows a net increment of 50.1% from 0.0694 MPa to 0.1042 MPa . This also supports the previous conclusion that use of polypropylene fibers for reinforcing soils like soil sample- 2 is recommended.

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