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SOIL STABILIZATION USING WASTE FIBER MATERIAL

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ABSTRACT

Soil is very important part in every construction work. But some types of soil could not bear the load, so we need to improve its properties. Structure which have constructed over the expansive soil may occurred several damage due to high swelling behavior. So these types of soil need to be stabilized by increase its shear strength, load bearing capacity and durability as well as to prevent from erosion. The new technique can be effectively used for soil stabilization by using waste materials. Various case studies have been carried out for these types of soil to increases its soil properties. The main objective of this study is to investigate the use of waste fiber material in geotechnical application and to evaluate the effect of waste polypropylene fibers on shear strength of soil by adding different percentage on the shear strength test of different types of soil samples. The laboratory tests were conducted like Specific gravity, Liquid limit, Plastic limit, Sieve analysis, Standard proctor test, direct shear and UCS test discriminative fiber contents. This aims of the project work to evaluate the effect of the addition of 0%, 0.05%, 0.15%, 0.25% reinforcement to stabilize the soil.

Keywords: Polypropylene fibers, Standard Proctor, UCS, Atterberg Limits, Specific gravity, Direct shear test

1. INTRODUCTION

Soil stabilization is the process in which we meliorate the physical parcels of soil by adding external agents. Soils are generally stabilized to increase their strength and continuity or to help corrosion and dust conformation in soils. The main end is the creation of a soil material or system that will hold under the design use conditions and for the designed life of the engineering design. The parcels of soil vary a great deal at different places or in certain cases indeed at one place; the success of soil stabilization depends on soil testing. colorful styles are employed to stabilize soil and the system should be vindicated in the lab with the soil material before applying it on the field. For any structure, the most important part of the structure is a foundation, which strongly carried out the entire weight of the structure. In order for foundation, soil plays the most important part in it. So work with soil, first of all, we have to have proper knowledge about its parcels and the factors which affect the behavior of the soil. The processes of soil stabilization enhance the parcels of soil and achieve the demanded need for the construction work. In recent times, the demand for structure, raw accouterments, and energy has increased, so soil stabilization has started to take a new shape. In India, the ultramodern period of soil stabilization began in the early 1970s, with a general insufficiency of petroleum and summations, it came necessary for the masterminds to look at means to ameliorate soil other than replacing the poor soil at the structure point. In recent times, with the increase in the demand for structure, raw paraphernalia, and energy, soil stabilization has started to take a new shape. With the vacuity of better exploration, paraphernalia, and outfit, it's arising as a popular and cost-effective system for soil enhancement. The enhancement in the shear strength parameters has been stressed and relative studies have been carried out using different styles of shear resistance dimension.

1.1 OBJECTIVE OF THE STUDY

- To evaluate the index properties of different soil samples.
- By using polypropylene fiber, the strength characteristics of the soil increases.
- Compare the strength properties between different soil samples with fiber and without fiber.
- The soil strength was increases by adding different percentage of polypropylene fiber.
- Observed the effect of fiber on the shear strength value and compressive strength of the soil.

2. MATERIALS USED

2.1 SOIL

The soil is collected from Near Phulnakhara and Naraj Cuttack. Different types of laboratory properties such as specific gravity, Atterberg limits, Standard proctor test, Direct shear test and UCS test. The physical characteristics of soil are summarized in Table-1 and Table-2.

Figure 1: Soil Sample-1

Figure 2: Soil Sample-2

Table 1: Properties of Soil sample-1

SL. NO.	PROPERTIES	VALUE
1	Specific gravity (G_s)	2.72
2	Grain size Distribution Coefficient of Uniformity (Cu)	1.362
3	Atterberg limits Liquid limit (%) Plastic limit (%)	 28.29 22.58
4	Compaction properties Optimum moisture content (OMC) (%) Maximum Dry Density (MDD) (gm/cc)	 12.60 1.91
5	Direct shear test Cohesion(kg/cm^2) Angel of internal friction(degree)	 0.325 47.72
6	U.C.S (MPa)	0.0562

Table 2: Properties of Soil sample-2

SL. NO.	PROPERTIES	VALUE
1	Specific gravity (G_s)	2.60
2	Grain size Distribution Coefficient of Uniformity (Cu)	1.362
3	Atterberg limits Liquid limit (%) Plastic limit (%)	 43.49 19.56
4	Compaction properties Optimum moisture content (OMC) (%) Maximum Dry Density (MDD) (gm/cc)	 17.02 1.96
5	Direct shear test Cohesion(kg/cm^2) Angel of internal friction(degree)	 0.351 27.82
6	U.C.S (MPa)	0.0692

2.2 POLYPROPYLENE FIBER

Polypropylene fiber (PPF) is light weight, high strength, and corrosion resistance polymer material. It is used as a agent in soil stabilization.

Figure 3: Polypropylene fiber

3. RESULT AND DISCUSION

3.1 LIQUID LIMIT TEST

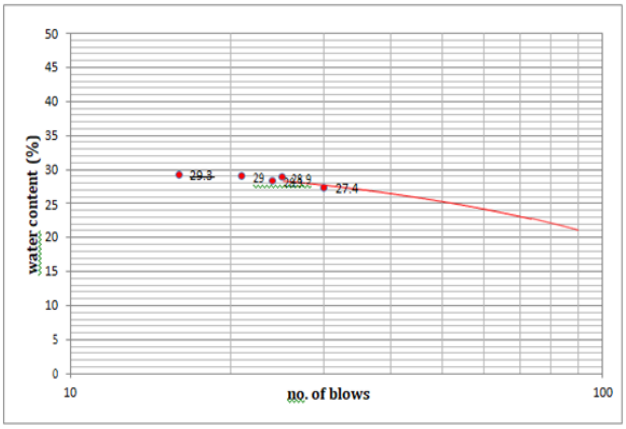

Figure 4: Liquid limit of Soil Sample-1

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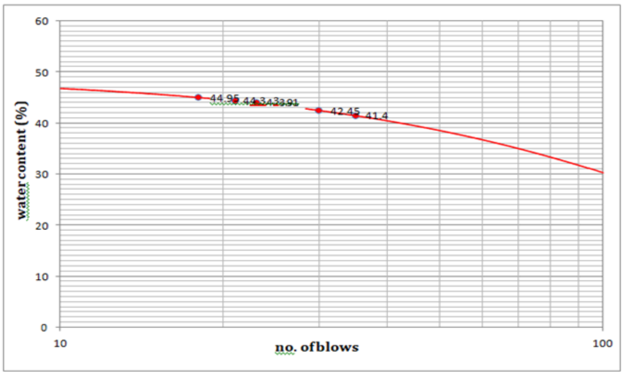

Figure 5: Liquid limit of Soil Sample-2

The above figure shows the liquid limit of two different types of soil. The liquid limit of soil sample 1 and 2 was 28.29% and 43.49% respectively.

3.2 SIEVE ANALYSIS TEST

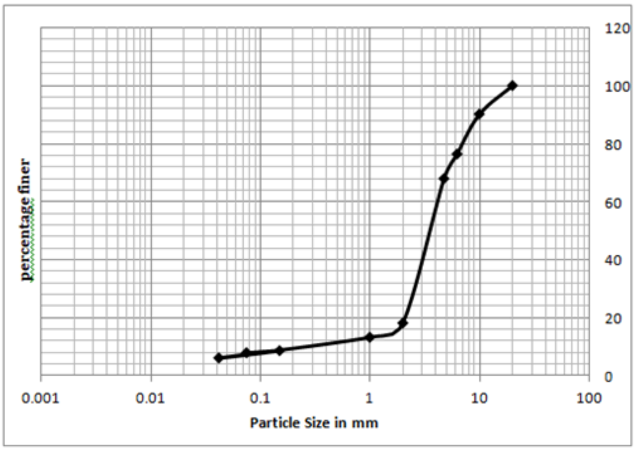

Figure 6: Sieve Analysis of Soil Sample-2

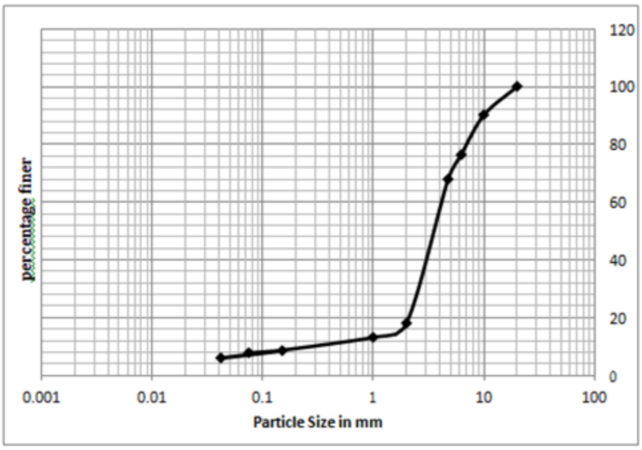

Figure 7: Sieve Analysis of Soil Sample-2

3.3 STANDARD PROCTOR TEST

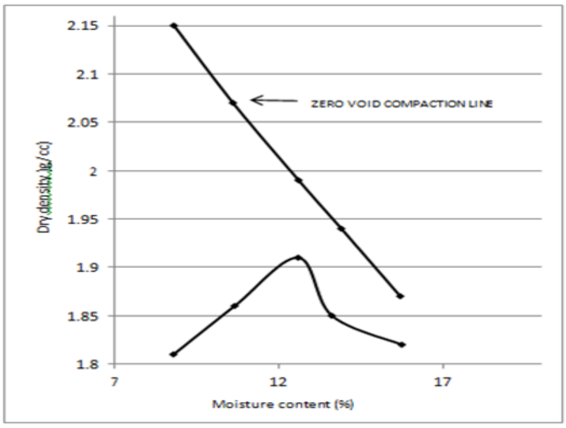

Figure 8: Compaction curve of Soil Sample-1

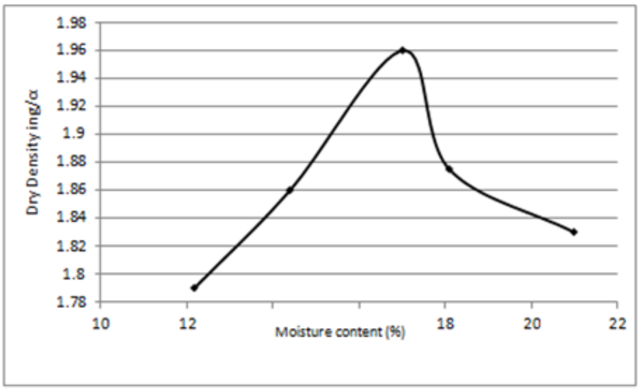

Figure 9: Compaction curve of Soil Sample-2

The above figure shows the OMC and MDD of different soil samples. The OMC and MDD of soil sample-1 was 12.60% and 1.91gm/cc respectively. The OMC and MDD of soil sample-2 was 17.02% and 1.96gm/cc respectively.

3.4 DIRECT SHEAR TEST

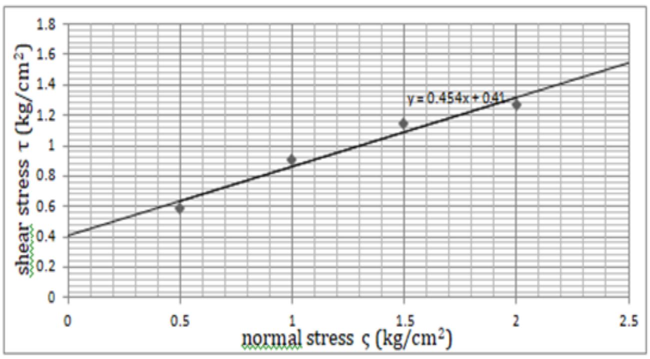

Figure 10: Mohr-Coulomb failure envelope of soil sample- 1 with 0 % reinforcement

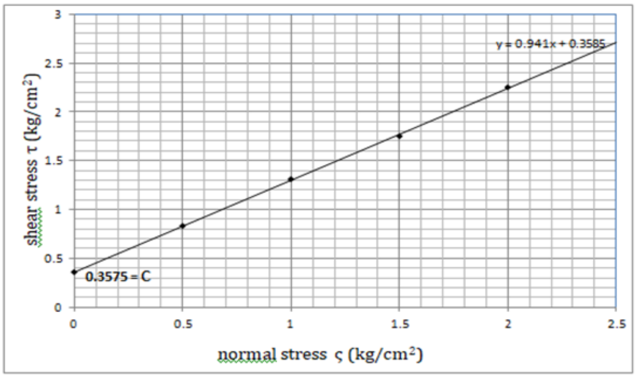

Figure 11: Mohr-Coulomb failure envelope of soil sample- 1 with 0.05% reinforcement

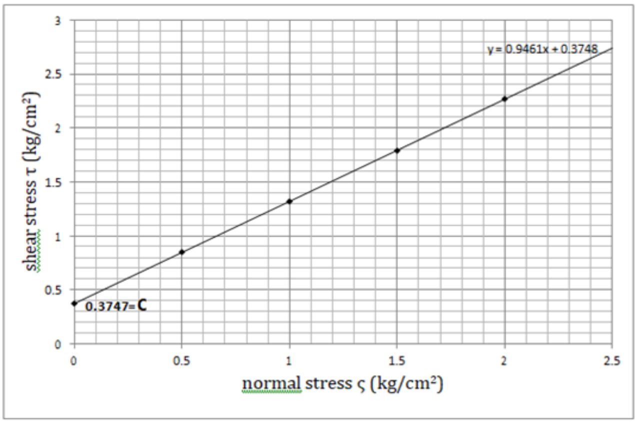

Figure 12: Mohr-Coulomb failure envelope of soil sample- 1 with 0.15% reinforcement

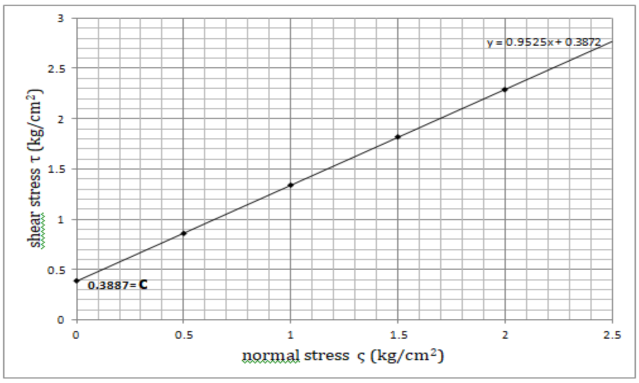

Figure 13: Mohr-Coulomb failure envelope of soil sample- 1 with 0.25% reinforcement

The above figure shows shear strength of soil sample-1 without and with reinforcement. The value of Cohesion of soil sample-1 with 0%, 0.05%, 0.15% and 0.25% of reinforcement was 0.325kg/cm², 0.357kg/cm², 0.374kg/cm² and 0.388kg/cm² respectively. The value of angel of internal friction of soil sample-1 with 0%, 0.05%, 0.15% and 0.25% of reinforcement was 47.72⁰, 48.10⁰, 48.25⁰ and 48.48⁰.

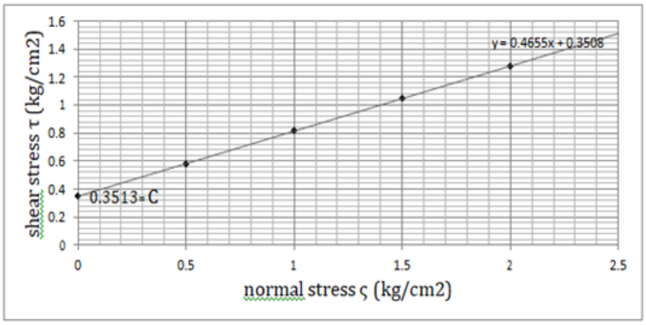

Figure 14: Mohr-Coulomb failure envelope of soil sample- 2 with 0 % reinforcement

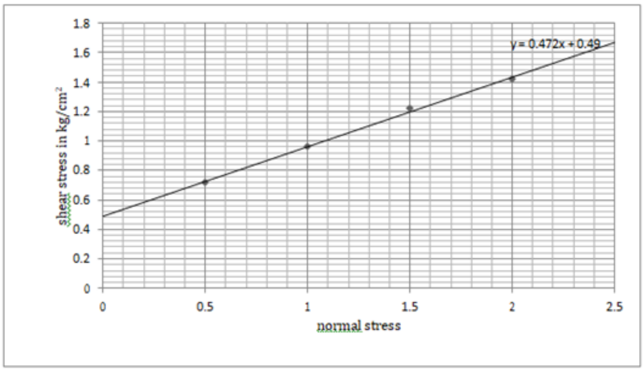

Figure 15: Mohr-Coulomb failure envelope of soil sample- 2 with 0.05% reinforcement

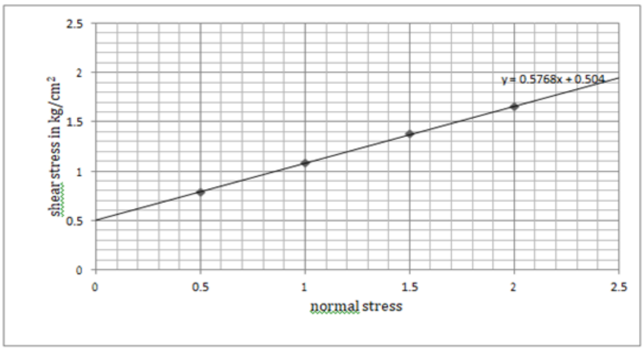

Figure 16: Mohr-Coulomb failure envelope of soil sample- 2 with 0.15% reinforcement

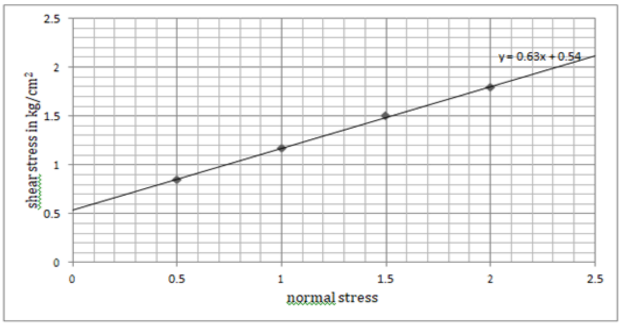

Figure 17: Mohr-Coulomb failure envelope of soil sample-2 with 0.25% reinforcement

The above figure shows shear strength of soil sample-1 without and with reinforcement. The value of Cohesion of soil sample-2 with 0%, 0.05%, 0.15% and 0.25% of reinforcement was 0.351kg/cm², 0.473kg/cm², 0.504kg/cm² and 0.537kg/cm² respectively. The value of angel of internal friction of soil sample-1 with 0%, 0.05%, 0.15% and 0.25% of reinforcement was 27.82⁰, 29.02⁰, 29.95⁰ and 32⁰.

3.5 UNCONFINED COMPRESSIVE STRENGTH TEST

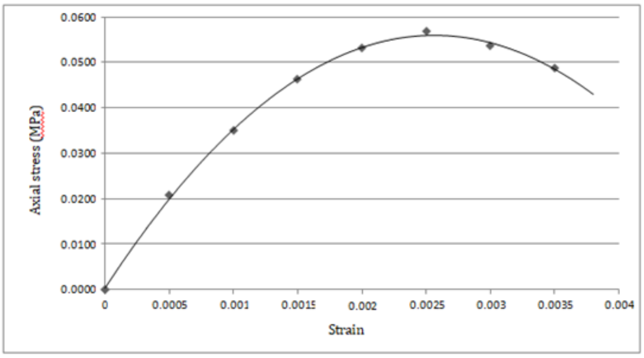

Figure 18: UCS curve for soil sample-1 with 0% reinforcement

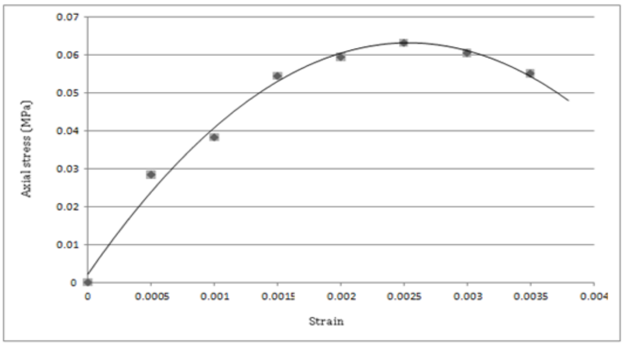

Figure 19: UCS curve for soil sample-1 with 0.05% reinforcement

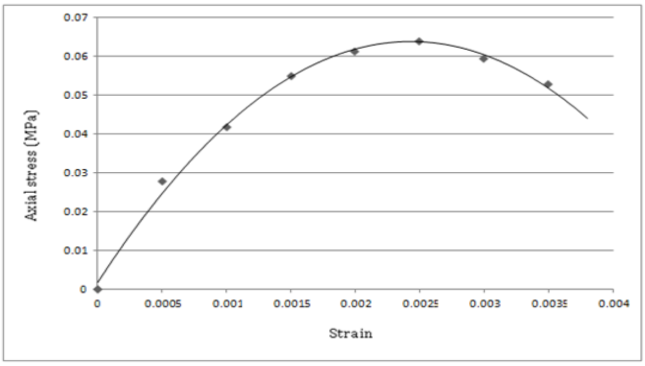

Figure 20: UCS curve for soil sample-1 with 0.15% reinforcement

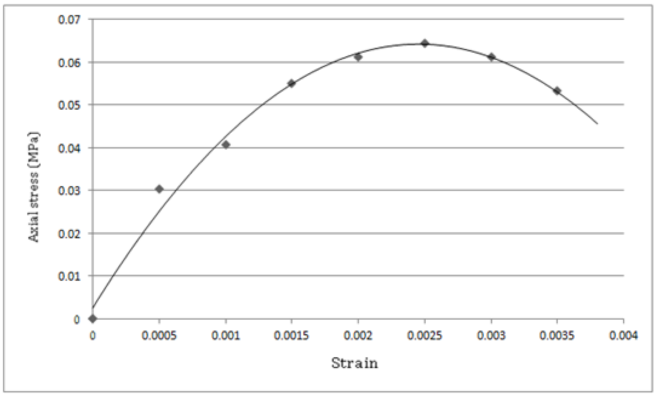

Figure 21: UCS curve for soil sample-2 with 0.25% reinforcement

The above figure shows compressive strength of soil sample-1 without and with reinforcement. The value of Cohesion of soil sample-1 with 0%, 0.05%, 0.15% and 0.25% of reinforcement was 0.056MPa, 0.0631MPa, 0.0637MPa and 0.064MPa.

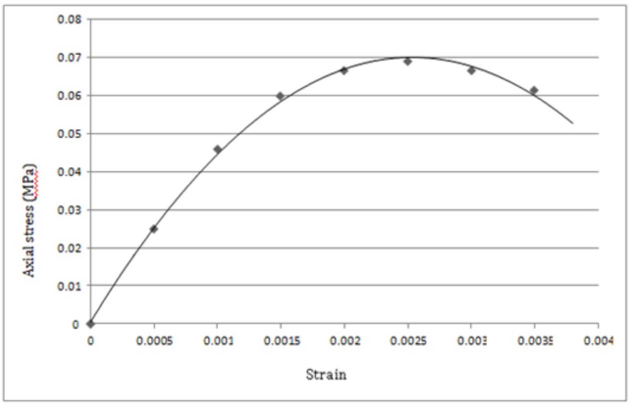

Figure 22: UCS curve for soil sample-2 with 0% reinforcement

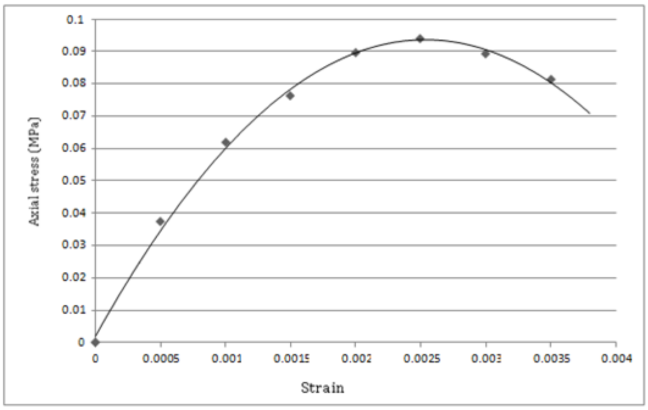

Figure 23: UCS curve for soil sample-2 with 0.05% reinforcement

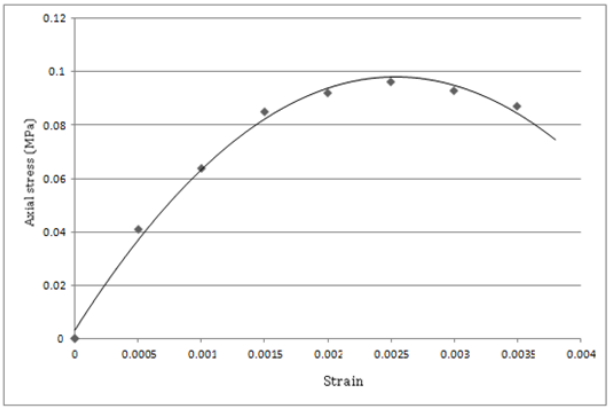

Figure 24: UCS curve for soil sample-2 with 0.15% reinforcement

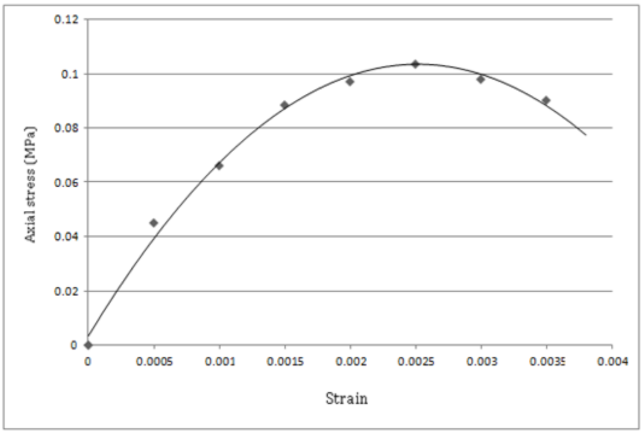

Figure 25: UCS curve for soil sample-2 with 0.25% reinforcement

The above figure shows compressive strength of soil sample-1 without and with reinforcement. The value of Cohesion of soil sample-1 with 0%, 0.05%, 0.15% and 0.25% of reinforcement was 0.069MPa, 0.093MPa, 0.096MPa and 0.103MPa.

4. CONCLUSION

Grounded on direct shear test on soil sample- 1, with fiber underpinning of0.05,0.15 and0.25, the increase in cohesion was set up to be 10,4.8 and3.73 independently. The increase in the internal angle of disunion(φ) was set up to be0.8,0.31 and 0. 47 independently. Since the net increase in the values of c and φ were observed to be19.6, from0.325 kg/ cm2 to0.3887 kg/ cm2 and1.59, from47.72 to48.483 degrees independently, for such a soil, aimlessly distributed polypropylene fiber underpinning isn't recommended. The results from the UCS test for soil sample- 1 are also analogous, for mounts of0.05,0.15 and0.25, the increase in unrestrained compressive strength from the original value are 11.68,1.26 and0.62 independently. This proliferation isn't substantial and applying it for soils analogous to soil sample- 1 isn't effective. The shear strength of soil sample- 2 the increase in the value of cohesion for fiber underpinning of0.05,0.15 and0.25 are34.7,6.09 and7.07 independently. Figure 27 illustrates that the increase in the internal angle of disunion(φ) was set up to be0.8,0.31 and 0. 47 independently. therefore, a net increase in the values of c and φ were observed to be 53, from0.3513 kg/ cm2 to0.5375 kg/ cm2 and15.02 from27.82 to 32 degrees. thus, the use of polypropylene fiber as underpinning for soils like soil sample- 2 is recommended. On comparing the results from UCS test of soil sample- 2, it's set up that the values of unrestrained compressive strength shows a net proliferation of49.8 from0.0692 MPa to 0.1037 MPa. This also supports the former conclusion that use of polypropylene filaments for buttressing soils like soil sample- 2 is recommended. Overall it can be concluded that fiber corroborated soil can be considered to be good ground enhancement fashion especially in engineering systems on weak soils where it can act as a cover to deep/ raft foundations, reducing the cost as well as energy.

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