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The effect of fiber reinforcement in sandy soils

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ABSTRACT

Fibre reinforcement has more or less established itself as a composite civil engineering material having significant effect in improving the static strength characteristics of granular soil like sand. However the behavior of fibre reinforced sand is rarely discussed in the literature. The present study illustrates the effect of randomly distributed polypropylene fibre reinforcement in modifying the characteristics of sand. The word sandy soil represents a soil which consists of more amount of sand particles and small amount of clay and silt particles. Sandy soils have fewer loads bearing capacity, less shear strength, less specific surface and they do not have any plasticity. The analysis was done by conducting Proctor compaction test, and unconfined compression tests and determination of consistency limits, specific gravity, and relative density, grain size analysis on the collected soil samples. Further, the compaction tests and unconfined compression tests are conducted on the soil samples reinforced with polypropylene fibres in order to investigate the strength characteristics of fiber-reinforced soil. These tests are to be conducted at both non-stabilized and stabilized states by adding 0%, 0.5%, 1%, 1.5%, and 2% of polypropylene fibre by weight of the soil sample. The results show the effect of polypropylene fibre on geotechnical properties of the soil samples. The use of hair-sized polypropylene fibers in sandy soil stabilization applications has been popular in soil stabilization projects for its low cost compared with other stabilization agents. These materials have a high resistance towards chemical and biological degradation and do not cause leaching in the soil.

Keywords: Consistency limits, Grain size analysis, Polypropylene fibers, Proctor compaction test, Unconfined compressive strength.

I.INTRODUCTION

Soil is highly complex, heterogeneous and unpredictable material which has been subjected to vagaries of nature, without any control. The properties of a soil depend not only on its type but also on the conditions under which it exists and loading and drainage conditions. In order for the safe and strong structure, 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 strength 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 utilized various methods to improve soil strength some of these methods were so effective that their buildings and roads still exist. Improvement of certain desired properties of soil like compaction unconfined compression; shear strength swelling characteristics can be undertaken by a variety of soil improvement techniques. There are many soil improvement techniques either chemical or mechanical. They may be classified as ground reinforcement, ground improvement, and ground treatment. All these techniques require skilled man-power and equipment to ensure adequate performance. Recently soil reinforcement is an effective and reliable technique for improving strength and stability of soils. The concept of earth reinforcement is an ancient technique and demonstrated abundant in nature by animals, birds and the action of tree roots. The nature is the best example of earth reinforcement. In nature, the roots of plant and trees hold the earth during heavy rain and cyclone. This reinforcement resists tensile stress developed within the soil mass thereby restricting shear failure. Reinforcement interacts with the soil through friction and adhesion. The inclusion of randomly distributed discrete fiber increases strength parameters of the soil same as in case of reinforced concrete construction.

II.SOIL TYPE AND THE REINFORCEMENT

2.1 Soil type

Sandy soil (cohesionless soil) was collected from Sikandrabad city of Uttar Pradesh. The soil is sandy silt with certain amounts of clay in it. It is an alluvium soil which is spread by slow moving rivers of the Ganges system. The Ganges is a major river in Indian subcontinent. It flows through the states of Delhi, Uttar Pradesh, Bihar and Haryana.

TABLE 1: Various properties of the sandy soil obtained

Natural moisture content (in-situ)	6%
Particle size distribution	Sandy silt
Specific gravity	2.67
Liquid limit	21.73%
Plastic limit	non plastic(NP)
Relative density	67.71% (dense sand)
Maximum Dry Density (g/cc)	1.873
Optimum moisture content (%)	16.23
Unconfined compressive strength test	0.076Mpa

2.2 Soil reinforcement (Polypropylene fibers)

The PP fibres have been widely used in experimental investigations of fibre reinforced soils. The primary attraction is that of low cost. It is easy to mix PP fibres with soil, and they have relatively a high melting point, which makes it possible to place the fibre-reinforced soil in the oven and conduct the water content determination tests. These fibres are a form of structural reinforcement, and their main role is working as a tension member to improve the strength characteristics of soil in addition to their roles in influencing other properties of soil.

The fiber is used as:

- Reinforcement (1) Polypropylene fiber with length 12mm , diameter 0.035mm
- Reinforcement (2) Polypropylene fiber with length 24mm , diameter 0.040mm

TABLE 2: Physical and Chemical properties of Polypropylene Fiber used

Physical and chemical properties	Values
Fibre type	Single fiber
Unit weight	$0.91 g/cm^3$
Diameter	0.034mm – 0.040mm
Length	12mm – 25mm
Breaking tensile strength	350Mpa
Modulus of elasticity	3500Mpa
Fusion point	16^0C
Burning point	590^0C
Acid and alkali resistance	Very good
Dispensability	Excellent

III. EXPERIMENTAL WORK

A series of tests were performed with sandy soil using polypropylene fibre as reinforcement at various percentage contents and aspect ratio to find out its effects on soil and find out whether the particular soil reinforcement is useful. The experimental work consists of finding out the contribution of fiber reinforcement taken in varying proportions (0%,0.5%, 1%,1.5% and 2% by weight of soil) and varying lengths (12mm and 24mm)and diameters (0.035 and 0.040mm) to the shear strength of sandy soils. To find out the compaction characteristics of sandy soil by going through a series of standard Proctor compaction tests. To investigate the main role and function of such reinforcement in modifying the stress-strain response of the sand through series of unconfined compression strength tests.

IV.RESULTS AND DISCUSSIONS

4.1 Proctor Compaction Tests: Proctor compaction test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become most dense and achieve its maximum dry density. The test is used for the determination of the relationship between the moisture content and density of

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soils compacted in a mould of a given size with a 2.5 kg rammer dropped from a height of 30 cm. The results obtained from this test will be helpful in increasing the bearing capacity of foundations, decreasing the undesirable settlement of structures, control undesirable volume changes.

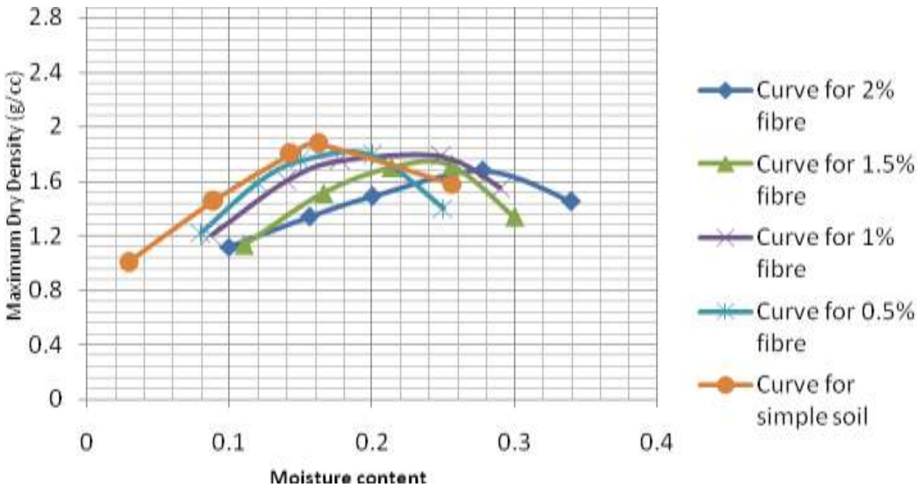

Figure 1: MDD and OMC for Different % of Polypropylene Fibers in Sandy Soil

(Fiber Length = 12mm and Diameter = 0.035)

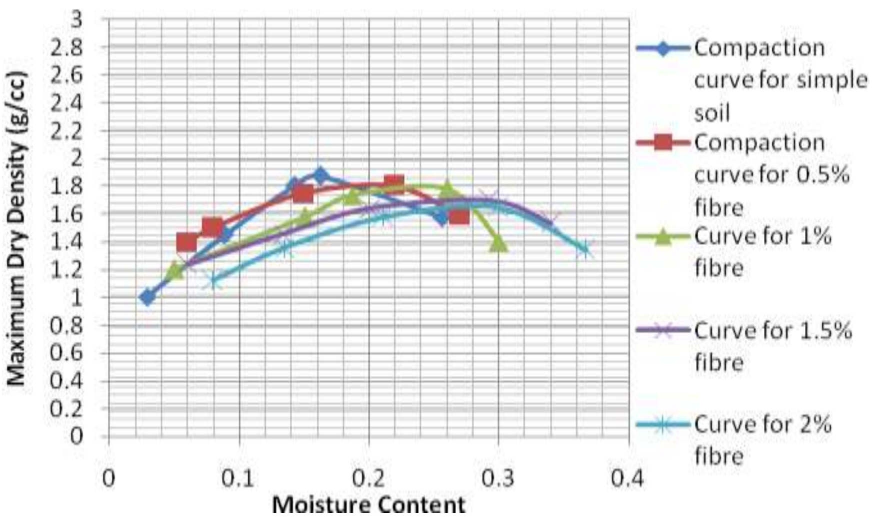

Figure 2: MDD and OMC for Different % of Polypropylene Fibers in Sandy Soil

(Fiber Length = 24mm and Diameter = 0.040mm)

From the compaction curves, it can be clearly indicated that by increasing in the percentage of polypropylene fibers in sandy soil, the maximum dry density value decreases and the optimum moister content value increases. The value of OMC increased from 16.23% to 27.8% and MDD decreased from 1.873g/cc to 1.678g/cc when the fiber content increased from 0 to 2%. This is due to the fact that fiber unit weight is very less comparatively and less than water and it replaces the amount of soil while compaction and water taken for compaction is also more.

4.1.1 Effect of fiber length and diameter:

When the fiber length and diameter are increased there is more contact of fiber with soil. More and more water is held in soil-structure mix resulting from fiber and soil interaction and more water is required as we increase the fiber content. The value of OMC increased from 16.23% to 30% and MDD decreased from1.873g/cc to 1.645g/cc when the fiber content increased from 0 to 2%.

4.2 Unconfined compressive strength test (UCT)

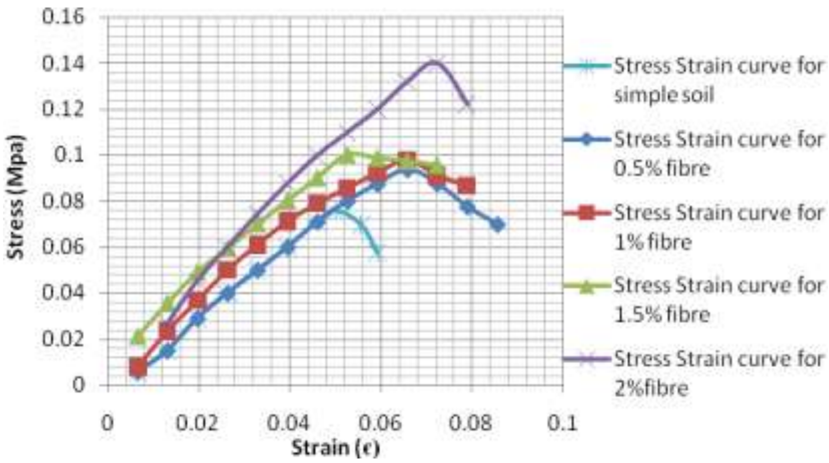

Figure 4: UCT for different % Of Polypropylene Fibers in Sandy Soil
(Fiber Length = 12mm and Diameter = 0.035mm)

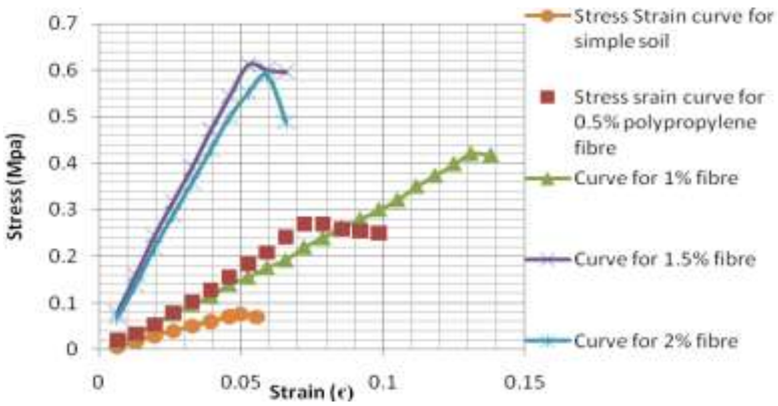

Figure 5: UCT for different % Of Polypropylene Fibers in Sandy Soil
(Fiber Length = 24mm and Diameter = 0.040mm)

In case of unconfined compression strength test, a chemical binding occurs between the minerals in the soil and the chemical elements present in the polypropylene fiber. With increase in the percentage of the fiber content, the strength of the soil increases from 0.076Mpa to 0.14001Mpa when the percentage of fiber is increased from 0 to 2%. As the fibers are good in resisting tension, reinforcement works as tensile resisting elements.

4.2.1 Effect of fiber length and diameter:

As the fiber length and diameter of the fiber is increased, more interlocking between the minerals and the chemicals take place. Both the shear strength and the angle of internal friction of the soil increases. The stiffness of the soil also increases and a stage is reached when one of the samples showed a brittle failure. With increase in fiber length and diameter, the value of UCS decreases from 0.6119Mpa to 0.5990Mpa when the fiber content increased from 1.5 to 2%.

V.CONCLUSION

Based on the test results of this study, the following conclusions may be drawn out:

- A series of compaction test were performed to evaluate the effect of fiber inclusion on Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) of sandy soil. Increasing in fiber percentage increased OMC of sandy soil samples and decreased maximum dry density.

In case of type (1) reinforcement (length = 12mm and diameter = 0.035mm), there is a gradual decrease of maximum dry density from 1.873g/cc to 1.673g/cc while as in type (2) reinforcement (length = 24mm and diameter = 0.040mm), the aspect ratio of the fiber is more , so there is more contact of soil and fiber and decrease of maximum dry density is seen more from 1.873g/cc to 1.645g/cc, increasing the optimum moisture content from 27.8% in type (1) to 30% in type (2).

- In case of unconfined compressive strength (UCS) test, the shear strength of sand increased by increasing the percentage of type (1) reinforcement with high flexibility. In 2% of polypropylene fiber mix with sandy soil shows very good UCS value as compared with normal soil and other soil mixes. In case of type (2) reinforcement, the increase in the aspect ratio resulted in increasing both the shear strength of the sand and angle of internal friction. The ductility of sand increased by adding both the types of reinforcements (1and 2). The maximum value was obtained at 1.5% PP fiber mix with sandy soil at type (2) reinforcement. At the same time the soil showed no peak strength at 2% fiber mix with soil at type (2) reinforcement with high aspect ratio. This may be attributed to the brittle nature of soil, on increasing the percentage of fiber content.

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, road pavement, reducing the cost as well as energy.

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REFERENCES

[1] Gray, D. H., and Al-Refeai, T. (1986). ‘‘Behavior of fabric-vs. Fiber-reinforced sand.’’ *J. Geotech. Engrg.* ASCE, 112(8), 804–820.

[2] Gray, D. H., and Maher, M. H. (1989). ‘‘Admixture stabilization of sands with discrete, randomly distributed fibers.’’ *Proc., XII Int. Conf. on Soil.*

[3] *Mech. and Found. Engrg*. Gray, D. H., and Ohashi, H. (1983). ‘‘Mechanics of fiber reinforcement in sand.’’ *J. Geotech. Engrg.* ASCE, 109(3), 335–353.

[4] Al-Refeai, T. (1991). ‘‘Behavior of granular soils reinforced with discrete randomly oriented inclusions.’’ *Geotextiles and Geomembranes*, 10, 319–333.

[5] Shivanand Mali and Baleshwar Singh Former PG Student, Department of Civil Engineering “A study on Shear Strength of Sand reinforced with Glass fiber*.” International journal of scientific and engineering research volume 4, May 2013.*