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A STUDY ON POLYPROPYLENE FIBER REINFORCEMENT ON SOFT CLAY

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ABSTRACT

Expansive soils are found in many parts of the world such kind of soil generally consists of active clay minerals. Geotechnical engineers face various problems while designing foundation because of clayey soil due to poor bearing capacity and excessive settlement. To overcome those problems researches concentrated on soil improvement techniques by adding fibers, lime etc to the soft soil. In this study various tests were conducted on soft clay soil with various proportions of polypropylene fiber, lime and combination of lime and fiber. Finally, it is observed that with combination of fiber and lime 20 to 30% strength improvement can be achieved.

Keywords: *Geosynthetics, Polypropylene, Reinforcement, Shear Strength*

1. 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 its plays a very important role. So, to work with soils we need to have proper knowledge about their properties and factors which affect their behavior. In order to satisfy the soil properties, the soil stabilization is very important so that the addition of lime and polypropylene fiber makes soil stabilization by arresting the cracks so that it improves strength. The addition of lime and polypropylene fiber decreases the optimum water content, and increases strength and maximum dry density and reduced the swelling potential, liquid limit, plasticity index [1-9]. But further addition can increase swelling in soils with high sulphate contents, decrease in plasticity of soils and excessive lime treatment contribute to brittle failure characteristics of soils that lead to rapid and great loss in strength when failure occurs. Herein this project soil stabilization has been done with the help of lime and randomly distributed polypropylene fibers, obtained from waste materials.

2. EXPERIMENTAL SETUP

2.1 Material Used

The type of soil used is Clay soil,collected from field located near the Airport of Agartala, Tripura.Shown in figure 1.

Clay Soil: A fine-grained natural soil materials containing clay materials. Clay soils remain wet and cold in winter and dry out in summer. Due to its mechanical property, clay develops plasticity when wet, due to a molecular film of water surrounding the clay particles. But become hard, brittle and non-plastic upon drying or firing. These soils are made of over 25 percent clay, and because of the spaces found between clay-particles, clay soils hold a high amount of water. And also due to the presence of impurities clay soil shows a variety of colours such as reddish or brownish colour from small amounts of iron oxide. These soils drain slowly and take longer to warm up in summer, combined with drying out and cracking in summer.

Lime: Calcium Oxide (Chuna / Safedi) with a common name Quicklime or burnt lime or un-slaked lime or pebble lime or calcia. It is also known as Safedi or Chuna in local market. It is an amorphous white solid with a high melting point of 2600^0C. It is obtained by calcining (controlled heating - time and temperature) limestone at temperatures above 900C. Its chemical formula is CaO. It is a very stable compound and withstands high temperatures. In the presence of water, it forms slaked lime. This process is called the slaking of lime. Added to the soil at three different portions (0.5, 1 and 1.5%) by weight. It is added to the soil, so as to neutralize the acids in it and bring the pH to around 7, which is optimum for plant growth and most importantly as it's neutral in pH, hence it's increases the soil's ability and foundation to stand acidic reactions free.Figure 2 shows the lime used in this study.

Fiber: Polypropylene fiber of 12mmcut length made high quality virgin polypropylene. Product brand: joganithe fiber is suitable for all kind of constructional work like road construction, infra-structure construction projects, etc. With great high alkali resistance and superior dispersion. eco-friendly, non-allergenic, heat-resistant, abrasion-resistant, anti-distortion, alkali resistant, easily dispersible. Due to its high tensile strength as compared to many materials, polypropylene's structure has a good tensile strength some- where around4,800psi. this allows heavy loads, despite being lightweight. propylene fiber, also known as polypropylene or pp, is a synthetic fiber, transformed from 85% propylene, and used in a variety of applications. it is used in many different industries, but one of the most popular is the manufacturing of carpet yarns. for example, most of the economical carpets for light domestic use are made from this fiber. The fiber is thermoplastic, resilient, light

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weight and resistant to mildew and many different chemicals. Figure 3 shows the polypropylene fiber reinforcement used in this study.

Fig.3 Fiber reinforcement

2.2 Apparatus:

1. Unconfined Compression Testing machine (strain controlled).
2. Sampling Tube.
3. Sample Ejector.
4. Deformation dial gauge – 0.01 mm graduations and specific travel to permit 20% axial strain.
5. Vernier Caliper – of least count 0.1 mm.
6. Timer.
7. Oven with accurate temperature control in the range 110°C +- 5°C.
8. A balance of 0.01 gm sensitivity.
9. Miscellaneous equipment such as specimen trimmer, carving tools, re- moulding apparatus, moisture cup, etc.

3. TEST PROCEDURES:

Undisturbed, compacted, or re-moulded specimens may be prepared, depending on the case.

1. Prepare undisturbed cylindrical specimens (38 mm diameter, 76 mm length) from large undisturbed field samples using a trimmer.Alternatively, directly obtain field samples in thin sampling tubes of the same diameter as that of the specimen.
2. Prepare a re-moulded compacted specimen, of any predetermined water content and density, in a large mould and then cut it using the sampling tube. Alternatively, prepare a re-moulded specimen from a failed undisturbed specimen by pushing the soil inside a split mould, with the same void ratio and natural water content.
3. In both the cases, the wet density and water content of the specimens are determined.
4. Measure the dimensions of the specimen. Weigh in the specimen and keep representative samples for water content determination.

5. Place the specimen on the bottom plate of the loading device and adjust the upper plate to make contact with the specimen asshown in the figure.

6. Adjust the deformation and proving ring dials to zero and apply the axial load with a strain rate of 0.5% to 2% per minute.
7. Record the force and deformation readings at suitable intervals, with closer spacing during the initial stages of the test.
8. Apply the load until the failure surfaces have definitely developed or until an axial strain of 20% is reached.
9. Carefully sketch the failure pattern, and if the specimen has failed with a pronounced failure plane, measure the angle of the failure surface with the horizontal.
10. Take water content representative samples from the failure zone of the specimen.

Fig. 4 UCS Sample

3.1 Preparation of samples:

1.All the soil samples are compacted at their respective maximum dry density (MDD) and optimum moisture content (OMC) corresponding to the standard proctor compaction test.

2. Content of fiber in the soil is depends on the weight of soil we have taken for conducting tests.

3. The different values adopted in the present study for the percentage of lime are 1%, 5%, 10% and fiber reinforcement is added constant about 1.0% for different percentages of lime.

4. In the preparation of samples, if fiber and lime is not used then, the air-dried soil is mixed with an amount of water that depends on the OMC of the soil.

5. If fiber and lime was used, the adopted content of fibers and lime was first mixed into the air dried soil in small increments by hand, making sure that all the fibers and lime were mixed thoroughly, so that a fairly homogenous mixture is obtained, and then the required water was added. Figure 4 and 5 shows all the UCS sample with different proportions of reinforcement.Figure 5 shows the UCS sample with various reinforcement condition.

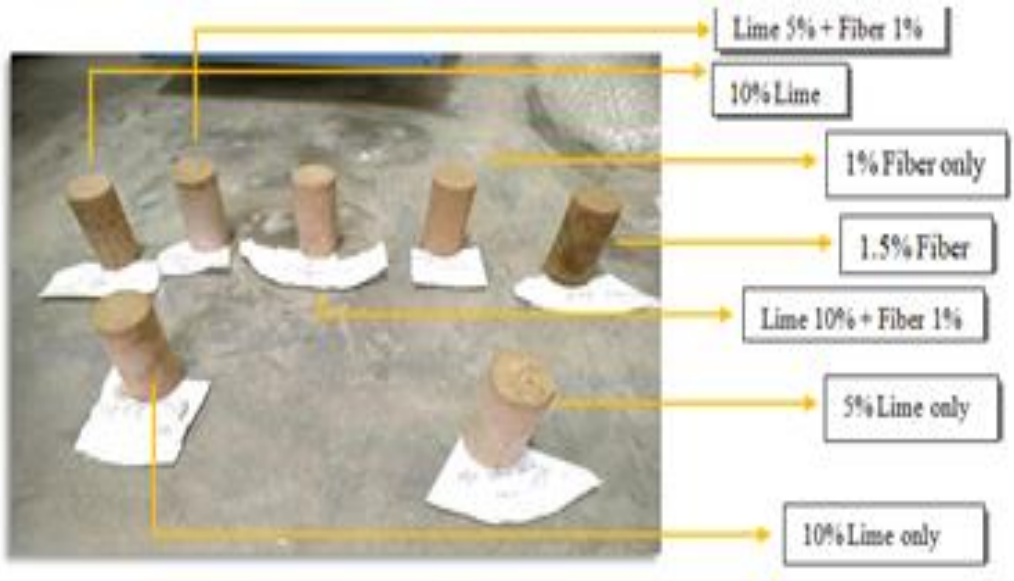

Fig. 5 UCS Sample with various reinforcement condition

4. RESULT AND DISCUSSION:

Basic parameter of clay soil is presented in table 1. Results obtained from the various UCS tests are presented through figure 6 to figure 8. Figure 6represent the variationof shear strength with various proportion of fiber reinforcement. From this graph it is clear that with the increase in fiber reinforcement shear strength of soil is increased and maximum shear strength improvement is observed with 2% fiber reinforcement. Figure7represent the variationof shear strength with various proportion of lime. It is clear from the graph that with the increase in fiber reinforcement shear strength of soil is increases as compared to unreinforced soil. Maximum percentage of shear strength improvement is observed with 5% lime after that further increase in lime percentage improvement in strength is negligible.Figure 8 shows thevariationof shear strength with combination of lime and fiber reinforcement. From this figure it is observed that with the combination of lime and fiber 20 to 30% strength improvement can be possible as compared to unreinforced soil.

Table 1. Basic parameters of clay soil used in this study.

Parameters	Value
Specific Gravity	2.6
Liquid Limit	26.61

Plastic Limit	21
Plasticity index	5.61
optimum moisture content	19.18
Maximum dry density	=1.6530 g/cm³
Uniformity coefficient	6

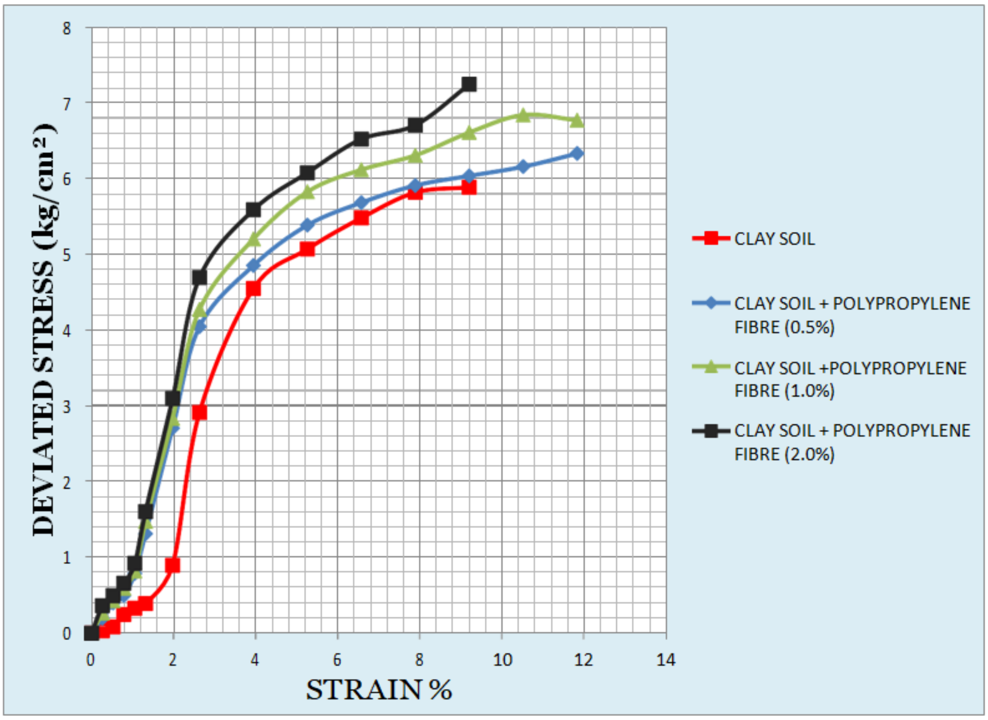

Fig. 6 Variationof shear strength with various proportion of fiber reinforcement.

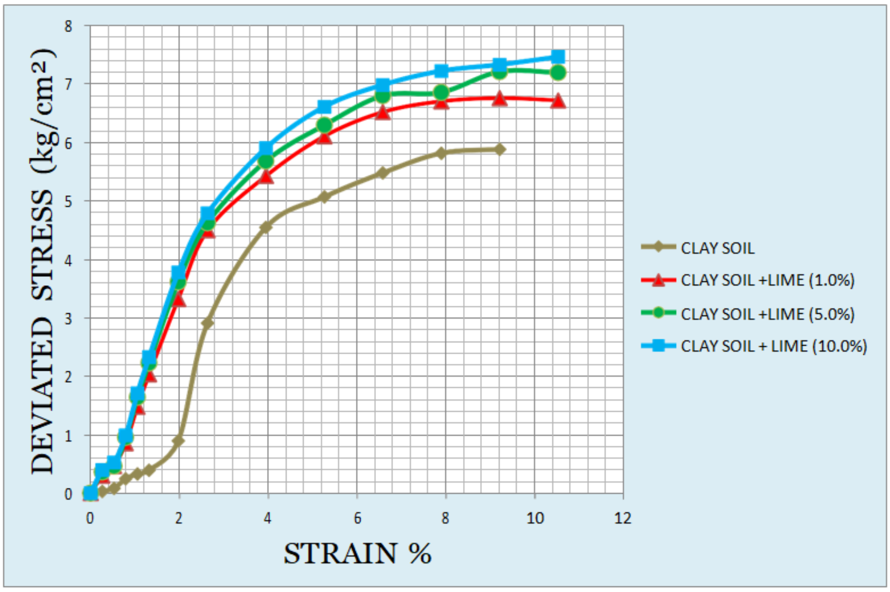

Fig. 7 Variationof shear strength with various proportion of lime.

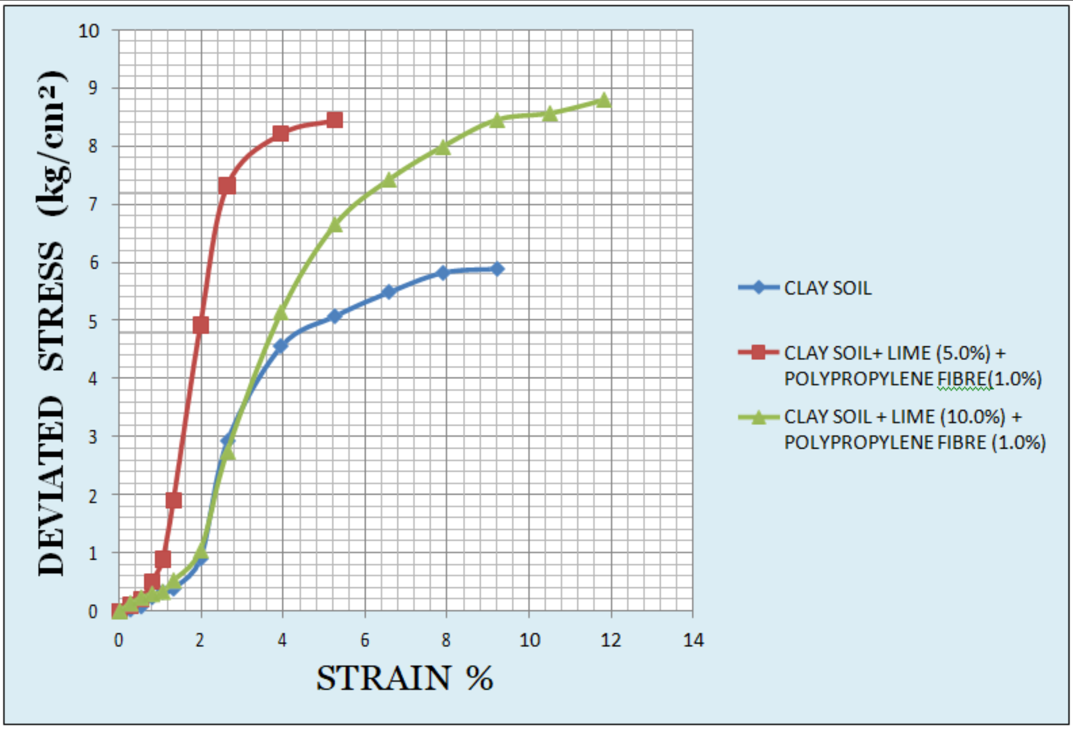

Fig. 8 Variationof shear strength with combination of lime and fiber.

5. CONCLUSIONS:

On the basis of present experimental study, the following conclusions are written

1. Addition of fiber content increased the % axial strain corresponding to failure thereby enhance the ductile behavior of soil and is expected to reduce the shrinkage settlement during desiccation which would help in reducing the detrimental damages to supported structures.
2. The result shows that the increase of the percentage of polypropylene fiber will result in increasing the shear strength of soil.
3. The shear strength of soil also increases with increasing the lime percentage with or without polypropylene fiber.
4. Use of polypropylene fiber reduced maximum dry density and increased the optimum moisture content of soil. As the length of polypropylene fiber increases the unconfined compressive strength of soil also increased.
5. On comparing the result of UCS test of soil It is also found that the values of unconfined compressive strength show a net increment with increasing the fiber percentage (0.5%, 1%, 1.5%) increasing the lime percentage (1%, 5%, 10%).
6. Overall it is observed that with the combination of lime and fiber 20 to 30% strength improvement can be possible as compared to unreinforced soil.

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