EXPERIMENTAL INVESTIGATION ON PLYSOIL REINFORCEMENT WITH GEOTEXTILES

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ABSTRACT

Soil is the major component in construction industries. If the construction work is carried out in a problematic soil, then it may leads to disasters or damages to the buildings. In order to avoid such problem the soil must be tested before every construction works. The strength of the soil must be improved. The new techniques like soil stabilization or soil reinforcement is done. For stabilization the low cost materials can be used. There are many agricultural wastes which can be used in this technique to improve the soil strength. Plysoil is nothing but the "composite material" i.e., soil mixed with the two or more natural fibres. It is also called as "RDFS" (Randomly Distributed Fibre Soil). The flexible nature of reinforced soil enables it to withstand large differential settlements without distress. In order to minimize the cost of ply soil locally available fibre such as coir, banana fibre is used. In order to increase the strength of the plysoil more while using prefabricated structures in hilly areas, the plysoil is reinforced with non-woven geotextiles. This can increase the strength and also it can control soil erosion. This paper clearly explains the improvement of the plysoil when reinforced with non-woven geotextiles by doing the various test such as CBR, Direct shear test.

Keywords: plysoil, Non-Woven getextiles, reinforcement.

I. INTRODUCTION

The term "Soil" has various meanings, depending upon the general professional field in which it is being considered. To an engineer, soil is the unaggregated or uncemented deposit of mineral or organic particles or fragments covering large portion of the earth's crust. Many structures were built during the medieval period (about 400 to 1400 A.D). One of the main problems they had was about the compression of soil and the consequent settlement of building. Hence nowadays before starting the construction works, site investigation is equally necessary for analyzing the safety or causes of failure of existing works, for selecting construction materials and for deciding upon the construction methods to be applied. In general, the purpose of a site investigation is to obtain necessary information about the soil and hydrological conditions at the site and to know the engineering properties of the soil which will be affected. Hence in order to avoid these unexpected problems in the soil, reinforcing the soil is the best way to strengthen the soil and to avoid settlement of the soil. Reinforced earth consists of a compacted soil mass within which reinforcing elements or membranes, usually in the form of horizontal strips of metal, fibre glass strips or geotextiles or rods of metals. The reinforced soil concept is essentially based in the mobilization of interfacial shearing resistance between the soil and reinforcement which in turn restrains the lateral deformation of the soil.

Review of literatures

From the study of literatures, the Non-Woven geotextiles are used in the soil or foundation structures to increase the strength of the soil. The natural fibres are also used in the soil reinforcement to improve the strength of the soil. The various form of the geotextiles are used in the soil reinforcement, in order to increase the shear strength, unconfined compressive strength and it also reduces the soil erosion.

Objectives of this study

The main objectives of the project work are to study the effects of the soil strength after the application of geotextiles. To reduce the differential settling and the soil erosion and to increase the stability and also to increase the shear stress distribution in the uniform manner. The increase of the friction angle and the load bearing has been studied for each percentage of the fibre.

II. EXPERIMENTAL PROGRAM

A. Introduction

The concept of plysoil reinforcement with the non-woven geotextiles is more feasible and desirable. This technology of soil reinforcement is cost effective and very easy to care out. The preparation of ply soil by one or more natural fibres is eco-friendly and is economic also. This is one of the promising technologies for soil reinforcement in order to reduce the settlement and to reduce the soil erosion in more economical way.

B. Soil Reinforcement

Soil reinforcement is the act of improving the soil strength to enable it supporting or carry more load. Soil reinforcement by fibre materials is considered an effective ground improvement method because of its cost effective, easy adaptability, and reproducibility. This is usually used at foundations of one or two story buildings. Soil reinforcement is a built environment protection is important because construction represents a major contribution to climate change, resource depletion and pollution at global level. The brightest sustainable strategy in ground engineering is the consideration of substituting to the non-biodegradable in a situation of short term ground improvement.

C. Material used for soil reinforcement

The following are materials used for plysoil reinforcement with non-woven geotextiles.

- Coir fiber
- Banana fiber
- Non-woven geotextiles

Coir being a biodegradable and environment friendly material is virtually irreplaceable by any modern polymeric substitutes. Coir fibres are extracted from the husk surrounding the coconut. Coir – the "golden fibre" is a 100% organic fibre. It is one of the strongest natural fibre because of its high lignin content.

Figure no. 1 Coir Fiber

Banana plant not only gives the delicious fruit but it also provides textile fibre, the banana fibre. These fibres are obtained after the fruit is harvested and fall in the group of bast fibres. It is light weight and its average fitness is 2400 Nm. It has strong moisture absorption quality.

Figure no.2 Banana fiber

Non-woven geotextiles have a wide range of applications in civil environmental engineering and construction projects. Nonwoven geotextiles are needle punched to form a strong fabric that retains its dimensional stability and is resistance to damage from the construction stresses.

Figure no.3 Non-Woven geotextiles

E. Preparation of Plysoil

Plysoil is prepared by randomly distributing the coir fibre and the banana fibre to the sand sample taken. The fibres are taken with respective to the quantity of sand taken for the respective test. The fibres are added at 2%, 4%, 6%, 8% and 10% to the sand sample taken. Thus the plysoil is prepared.

F. Testing on plysoil

The tests done on plysoil are as follows;

- Direct Shear Test
- California Bearing Ratio

1. Direct Shear Test

For the given density the weight of soil sample required is calculated. The calculated weight of sand sample is placed in layers. Each layer is tamped to the required density. The top grip plate and loading pad is placed on the top of This test is done to find out the frictional sample of the taken sample. The angle of friction is a function of the relative density of compaction of sand, grain size, shape and distribution in a given soil mass. For given sand, an increase in the void ratio (i.e., a decrease in the relative density of compaction) will result in a decrease of the magnitude. However, for a given void ratio, an increase in the angularity of the soil particles will give a higher value of the soil friction angle. The apparatus used for this experiment are shear box assembly, balance, proving ring, dial gauge, weights.The shear box assembly is put together using the pin. The bottom grid plate is placed in position, so that the groove in the grid plate

D. Properties of soil

PROPERTIES	VALUES
Specific gravity	2.00
Grain Size Distribution a) Gravel b) Sand c) Fines	 Nil 79% 6%
Proctor Compaction test a) Maximum Dry Density (g/cc) b) Optimum Moisture content (%)	 2.01 g/cc 10%
Field density test-core cutter test a) Wet density b) Wet unit weight c) Dry density d) Dry unit weight	 0.8691 gm/cm3 8.455kN/cm3 0.0699g/cc 0.686 kN/cu.m.
California bearing ratio(CBR) 2.5 mm 5mm	 7.82% 10.67%
Direct shear test	53.12

should be perpendicular to the direction of shear. The normal load frame is placed on the loading pad. The proving ring is set to read zero. The required normal load is applied. The pin from shear box assembly is removed. The separating screw is turned to have a gap of 1mm between the two halves. The hand wheel is rotated to apply the shear load. The maximum deflection is recorded in the proving ring which gives the maximum shear stress. The shear load is released, the normal load and the shear box is removed. The test is repeated with a fresh sample of soil for the other normal loads. The graph between the normal stress and the corresponding shear stress at the failure is drawn. The shear parameter φ is found out from the graph. The same procedure is done by adding the fibres such as coir fibre and the banana fibre at a percentage of 2%, 4%, 6%, 10% to the sand sample taken. Then the friction angle φ is found out for each percentage of fibre addition to the sand sample.

PERCENTAGE	FRICTIONAL ANGLE
4%	61.20
6%	64.0
8%	62.32
10%	60.21

2. California Bearing Ratio

This test is done to find out the California bearing ratio by conducting a load penetration test. The apparatus used for doing this experiment are cylindrical mould, metal rammers, weights, two dial gauges. A sand sample of 5kg has been taken and 10% of moisture content has been added. Then 2% of coir fibre and banana fibre has been randomly distributed. Place the sand sample in the mould in three layers with each layer damping of 56times. Then place the mould assembly with the surcharge weights on the penetration test machine. Seat the penetration piston at the center of the specimen with the smallest possible load. Set the dial gauge reading to zero. Apply the load on the piston so that the penetration rate is about 1.25mm/min. Record the load reading at the penetration of 0.5, 1.0, 1.5, 2.0, 2.5, 5.0, 7.0, 7.5, 10, 12, and 12.5mm.Note the maximum load and corresponding penetration if it occurs for a penetration less than 12.5mm. Detach the mould from the loading equipment. Take about 20 to 50 g of soil from the top 3cm layer and determine the moisture content. At finally the penetration value has been taken for 2.5mm and 5mm penetration. The same procedure is done for the 4%, 6%, 8% and 10% of coir and banana fibre.

PERCENTAGE	2.5mm	5mm
0%	7.82%	10.67%
2%	7.05%	9.61%
4%	9.00%	11.88%
6%	10.04%	12.55%
8%	9.63%	11.60%
10%	9.55%	10.28%

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The fibre has been added to the soil in the order of 2%, 4%, 6%, 8%, and 10%. Thus the plysoil is prepared and it is reinforced with geotextiles. The geotetiles is added to the soil as a layer between the soil and various tests has been conducted to check the strength obtained. The tests done are as follows direct shear test and CBR test.

1. Direct Shear Test

For the given density the weight of soil sample required is calculated. The calculated weight of sand sample is placed in layers. Each layer is tamped to the required density. The top grip plate and loading pad is placed on the top of This test is done to find out the frictional sample of the taken sample. The angle of friction is a function of the relative density of compaction of sand, grain size, shape and distribution in a given soil mass. For given sand, an increase in the void ratio (i.e., a decrease in the relative density of compaction) will result in a decrease of the magnitude. However, for a given void ratio, an increase in the angularity of the soil particles will give a higher value of the soil friction angle.The apparatus used for this experiment are shear box assembly, balance, proving ring, dial gauge, weights. A sand sample has been taken and 2% of coir and banana fibres have been added and plysoil is prepared and this sample is placed in the mould with a layer of non-woven geotextile in between the soil and the test is conducted as per the procedure. The shear box assembly is put together using the pin. The bottom grid plate is placed in position, so that the groove in the grid plate should be perpendicular to the direction of shear. The normal load frame is placed on the loading pad. The proving ring is set to read zero. The required normal load is applied. The pin from shear box assembly is removed. The separating screw is turned to have a gap of 1mm between the two halves. The hand wheel is rotated to apply the shear load. The maximum deflection is recorded in the proving ring which gives the maximum shear stress. The shear load is released, the normal load and the shear box is removed. The test is repeated with a fresh sample of soil for the other normal loads. The graph between the normal stress and the corresponding shear stress at the failure is drawn. The shear parameter φ is found out from the graph.The same procedure is done by adding the fibres such as coir fibre and the banana fibre at a percentage of 4%, 6%, and 10% to the sand sample taken with a layer of geotextiles. Then the friction angle φ is found out for each percentage of fibre addition to the sand sample.

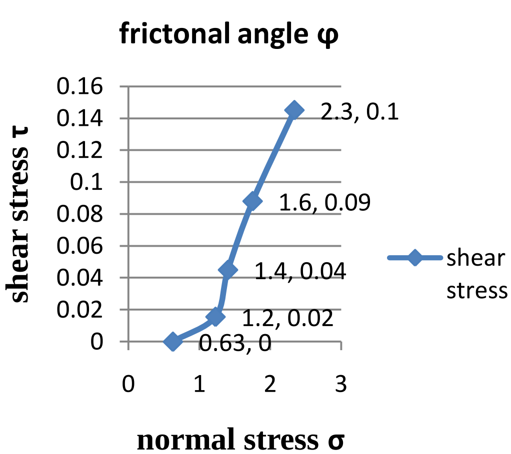


Figure no.4 frictional angle(sand + non-woven geotextile)

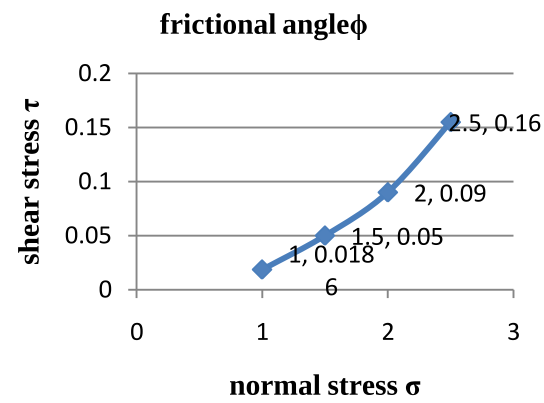


Figure no.5 plysoil(2%) + non-woven geotextiles

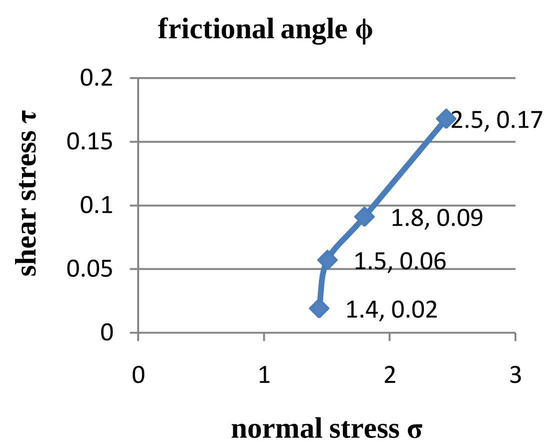


Figure no.6 plysoil (4%) + non-woven geotextiles

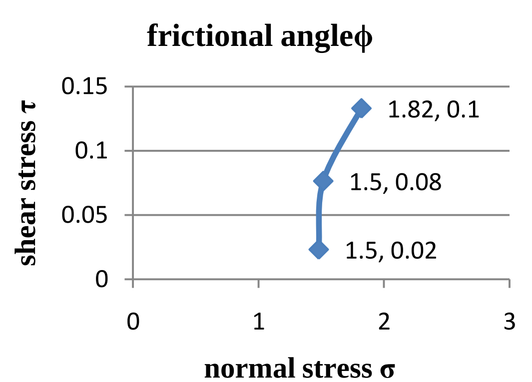


Figure no.7 plysoil (6%) + non-woven geotextiles

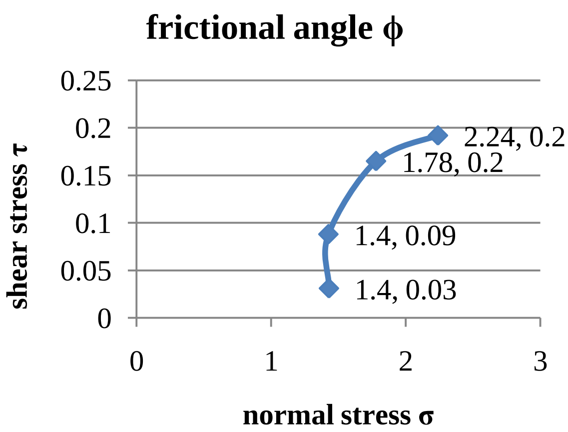


Figure no.8 plysoil(8%) + non-woven geotextiles

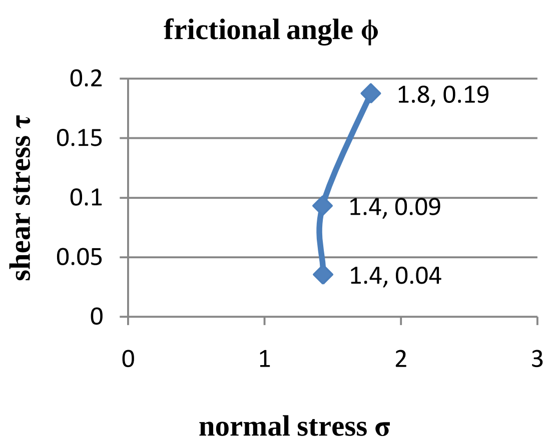


Figure no.9 plysoil(10%) + non-woven geotextiles

1. California Bearing Ratio

PERCENTAGE	FRICTIONAL ANGLE
0%	85.09
2%	85.43
4%	86.16
6%	87
8%	87.72
10%	87.39

This test is done to find out the California bearing ratio by conducting a load penetration test. The apparatus used for doing this experiment are cylindrical mould, metal rammers, weights, two dial gauges. A sand sample of 5kg has been taken and 10% of moisture content has been added. Then 2% of coir fibre and banana fibre has been randomly distributed. After the preparation of plysoil, a layer of Non-woven geotextile has been applied in between the layers of the plysoil and the mould assembly is setup.

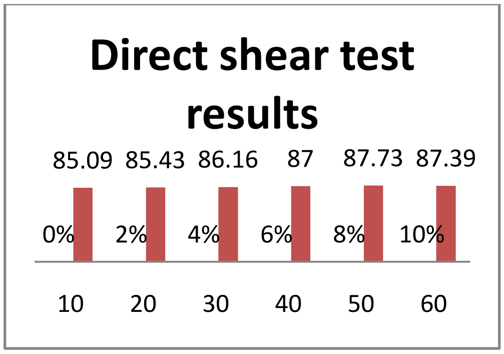
Place the sand sample in the mould in three layers with each layer damping of 56times. Then place the mould assembly with the surcharge weights on the penetration test machine.Seat the penetration piston at the center of the specimen with the smallest possible load. Set the dial gauge reading to zero.

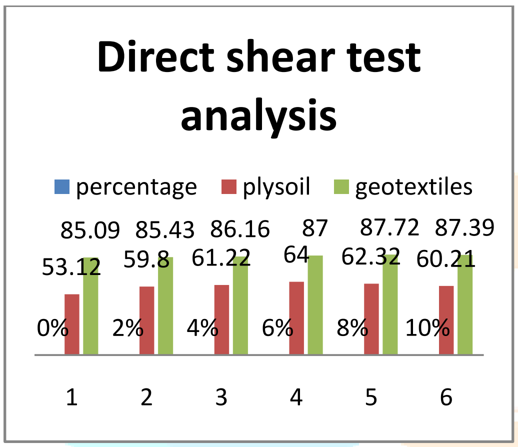
Apply the load on the piston so that the penetration rate is about 1.25mm/min. Record the load reading at the penetration of 0.5, 1.0, 1.5, 2.0, 2.5, 5.0, 7.0, 7.5, 10, 12, and 12.5mm. Note the maximum load and corresponding penetration if it occurs for a penetration less than 12.5mm.

Detach the mould from the loading equipment. Take about 20 to 50 g of soil from the top 3cm layer and determine the moisture content. At finally the penetration value has been taken for 2.5mm and 5mm penetration. The same procedure is done for the 4%, 6%, 8% and 10% of coir and banana fibre.

IV RESULTS

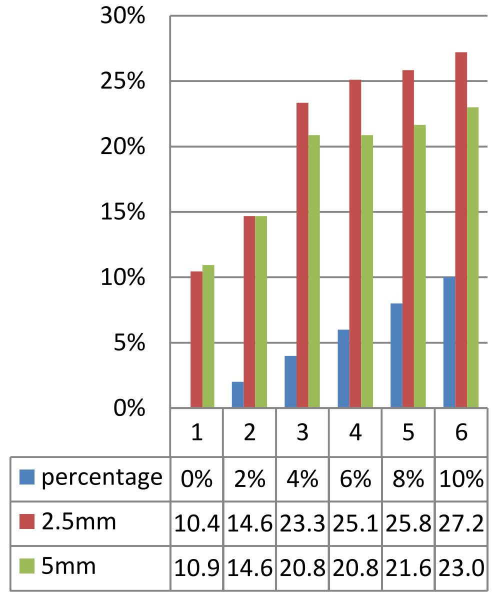
1. Direct Shear Test Results (plysoil reinforced with non-woven geotextiles)





2.California Bearing Ratio Results

PERCENTAGE	2.5mm	5mm
0%	10.46%	10.95%
2%	14.69%	14.69%
4%	23.35%	20.87%
6%	25.10%	20.87%
8%	25.84%	21.65%
10%	27.22%	23.01%



V CONCLUSION

Based on the experimental investigations carried out the following conclusions are arrived at:

According to the results obtained in the sieve analysis, we got the sample as sand from selected material. Therefore we carried out two tests for sand namely CBR and DIRECT SHEAR. The optimum percentage for the preparation of plysoil is 2% to 6% because the load bearing and the frictional angle value increases till 6%. After that the value decreases. While the plysoil is reinforced with the non-woven geotextiles the value goes on increasing. The CBR value increases with the addition of layer of non-woven geotextiles for all percentage of addition of fibres to the soil in the preparation of plysoil. Same in Direct shear test the frictional angle goes on increasing by the addition of layers of geotextiles. It is evident that the compaction, shear strength, load bearing capacity increases when the plysoil is reinforced with the non-woven geotextiles. Hence this type of reinforcement to the soil helps to improve the strength and reduce the erosion due to the reinforcement of non-woven geotextiles. Mostly this is used in hilly areas and in precast concrete works.

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