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APPLICATION OF GEO-SYNTHETICS IN THE STABILIZATION OF SLOPES OF NON-COHESIVE SOILS

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ABSTRACT

This study is focused on the interactive behavior of geo-synthetics in the stabilization of the slopes of non-cohesive soils. Now-a-days geo-synthetics are playing crucial role in geo-technical applications for strengthening of soils for slope stabilization, soil reinforcement for foundations, RE walls for flyovers on highway constructions, high retaining walls and water conveyance structures etc. Generally cohesion less soil is preferred for backfills of the embankments because of its excellent drainage properties, low hydrostatic pressure built-up on slopes / backfills and high internal resistance due to friction and interlocking. But when we encounter a situation, where we have low strength or poorly graded sandy soils available for back fills and for the cost matrix to be within the budgetary provisions, alternative techniques like soil reinforcement or soil stabilization have to be adopted. To study this property of geo-synthetics, direct shear test is conducted on the soil with and without geo-synthetics for analysis of shear parameters of soil under study. On application of mosquito net as reinforcement on non-cohesive soils, the sliding friction of the soil is enhanced by 22% that impacted the shear strength to be increased by 26.5%. Hence the soil's lateral load resistance or load transfer capacity increased to prevent the slope failure thereby saves the entire structure. So the use of geo-textiles or geo-synthetics will enhance the shear strength properties of the sandy soils and will reduce overall cost of the project.

Keywords: *Geo-synthetics, soil-reinforcement, interaction behavior, back fills, direct shear test.*

I. INTRODUCTION

Wherever the soil is poor in transfer of tensile loads, the soil reinforcement technique is widely used in the area of geotechnical engineering, as necessitated in the modern era of space and land constraints, rapid industrialization and high competition on speed of construction. Technically, these soil reinforcement techniques are used to increase the shear parameters of a soil. Here the good tensile strength properties of Geo-synthetics are used to increase the shear strength parameters of the soils.

Different types of soil reinforcing synthetics are available. They are geo-textile, geo-grids and geo-nets etc. We have chosen mosquito net to be used as soil reinforcing material to create a prototype model of the geo-synthetic here to study the change in shear resistance parameters of a sandy soil (Non-cohesive soils) because the mosquito net has almost same properties as that of the geo-synthetic, less in cost and also easily available. In reinforcement of soils, the interactions of soil with the reinforcing material play a crucial role. Two critical parameters of the interaction behavior of soil are the sliding over the reinforcement and pullout resistance. But this study is mainly focused on sliding over the reinforcement. Hence the direct shear test is used for study of sliding mechanism of soil over this geo-synthetic reinforcing material which can replicate the mechanism of shear along the likely failure plane in reinforced earth structure. Simulation of model prepared and analysis of the shear parameters can be done by proper replication of soil-geo-synthetic interaction mechanism in direct apparatus which is a crucial part of the whole testing.

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II. MATERIALS AND METHODS

2.1 Materials

The sandy soil samples are collected from the construction site located near the banks of the Krishna River to conduct direct shear test to evaluate the interaction parameters of soil with mosquito net as reinforcement material. Various physical tests like grain size distribution, relative density and specific gravity are conducted on the soil sample. The results of the same are, from the gradation, the effective diameter of particle at 10% finer is 0.26mm, at 30% finer is 0.43mm and at 60% finer it is 0.64mm. The specific gravity of the soil sample is found to be 2.475. Natural water content was found to be 4.25% at time of sampling. The constant permeability head test is done on the soil sample.

From the relative density

eMax= 0.693 and eMin= 0.513 .

Table 1: properties of soil sample used in study

D60	D30	D10	Cc	Cu
0.64	0.43	0.26	1.11	2.46

According to IS classification the soil sample is named as poorly graded and represented as SP.

Table 2: Classification of soil

Krishna river sand (Near undavalli area	Fines (%)	Classification
Sandy soil	0.15	SP
Color and Zone	Light brown	III

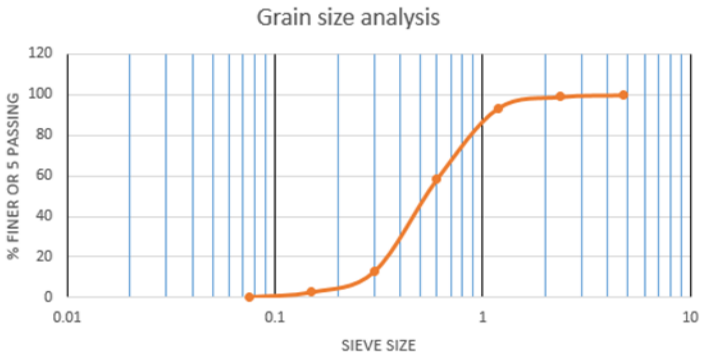

Figure 1: Grain size distribution curves of soil

2.2 Mosquito net

The mosquito net is preferred to be used in this work as our testing material because of its easy availability and less in cost when compare with the other geo-synthetics. It is made of polymeric material and possesses good tensile strength properties.

III. TESTING APPARATUS AND PROCEDURE

3.1 Direct shear apparatus:

This apparatus mainly consist of shear shackle with dimensions of 60mm X 60mm containing lower box as well as upper box. The following modification is done to shackle for analysis of soil and geo-synthetic interaction behavior.

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A rigid wooden block is chopped in such a way that it can be fitted to lower half of the shear shackle of dimensions 60mm X 60mm X 25mm. Then top face of the wooden block is covered by mosquito net in two layers as shown in fig 2. The wooden block is fitted into the lower half of the shear shackle.

Figure 2: mosquito net clamped to wooden block

After placing the wooden block in the lower box of the shackle, the upper box of shear shackle is clamped to the shackle over the lower shackle using screws.

3.1 Direct shear test procedure:

The testing procedure is followed similar to that of the shear test conducted on geotechnical materials except the slight modification is done to apparatus as explained above.

The water is added to the soil sample before filling it in the shear shackle up to its optimum level. Then upper box is filled by the soil sample in three layers by apply equal blows for every individual layer with help of small glass tamping rod so that same compaction energy is maintained for every layer and also every trail. The load is applied from the top using loading arm fixed to apparatus vertically to sample which acts as the normal stress. The testing of sample is done three different normal stress of 0.7, 1.4 and 2.1 kg/cm2.The vertical load is kept constant during the shearing process. The load applied was measured by the proving ring and horizontal displacement is measured by the dial gauge. The rate of horizontal displacement is applied at 0.5mm/min. At each and every normal stress three trails are done. Totally 18 trails are done which includes 9 trail without using mosquito and 9 trails using mosquito net. The average of three trails at each normal stress is taken as peak shear stress respectively. For all the trails same procedure is followed. For all the trails rate of shearing is 0.5mm/min.

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Figure 3: wooden block fitted into shear shackle.

IV. FUTURE WORK

In this work the testing is done on sandy soil. But this work can be extended by replacing the soil other soils like clayey soils and gravel etc.

The material used for soil reinforcement in this work is mosquito net but this also can be carried out by replacing this material with various other materials like polymeric fibers and other geo-synthetics.

This work can be extended further by using various combinations of geo-synthetic materials for different soils at different normal stress conditions.

By obtaining the above results, a comparison of these results with the sandy soil can be drawn to understand more closely the relative soil and geo-synthetic (reinforcement) interactive behavior of the samples.

V. RESULT AND DISCUSSION

To evaluate the shear stress response of the sandy soil under consideration by using mosquito net as reinforcing material, direct shear test is conducted at different normal stresses. The following results, physical and engineering properties, as found for the soil considered are tabulated below.

Table 3 Physical properties of soil

Property	Obtained value
Specific gravity	2.475
Relative density (%)	52.7
Grainsize analysis	Classified as SP
eMax (loose state)	0.693
eMin (dense state)	0.513
Void ratio (natural)	0.598
Bulk density and NMC of the sandy soil	1.46g/cc (4.5%)

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Table 4 Engineering properties of soil:

Property	Obtained value
Permeability	5.12*10-4 cm/s
Max Shear strength(without using net)	0.997 kg/cm2
Max shear strength(with using net)	1.261 kg/cm2

From the results above, it can be understood that net is applied at a distance of 2.5cm from the topo of the soil. We can notify the change in the shear parameters of the soil. From the of direct shear test the angle of internal friction of soil i.e.., slope of the graph between normal stress and shear stress without using mosquito net obtained as 25.4 in the similar manner the angle of

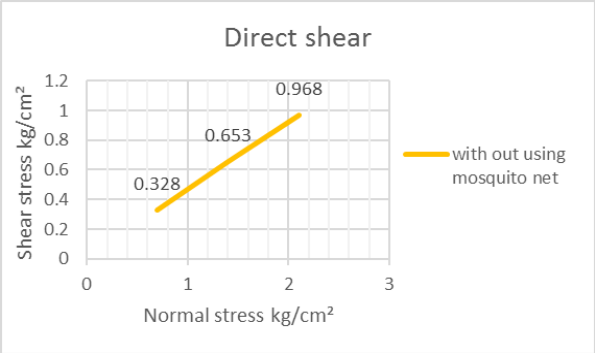

Figure 4: Normal stress VS shear stress graph without using mosquito net

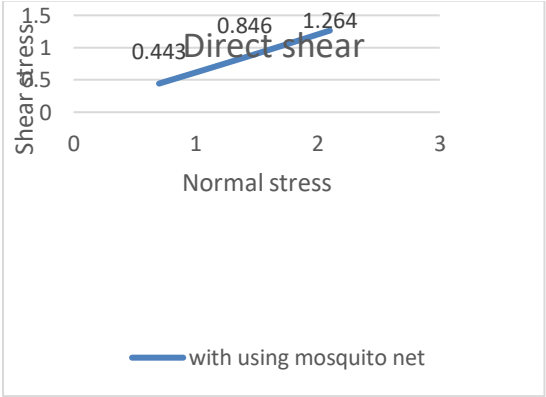

Figure 5: Normal stress vs shear stress graph with using mosquito net

Internal friction of soil tested using the mosquito net reinforcing material is obtained as 31o and hence the angle of internal friction of the soil is increased by 22%. Thus enhanced shear parameters have direct influence on the soil's shear strength to increase considerably. These soil reinforcement techniques can be applied for strengthening of the weak soils, in the construction works like embankments and retaining walls in road construction etcetera, where there is no other option available except using weak soils. Soil is constructions activities.

We have calculated shear stress of the soil at 0.7 kg/cm2, 1.4 kg/cm2 and 2.1 kg/cm2, also calculated the shear strength of soil according to Coulomb–Terzaghi equation is:

$$s = c + \sigma.\tan \phi$$

Shear strength of soil before reinforcing:

$$\rightarrow S1 = \sigma.\tan 25.4$$

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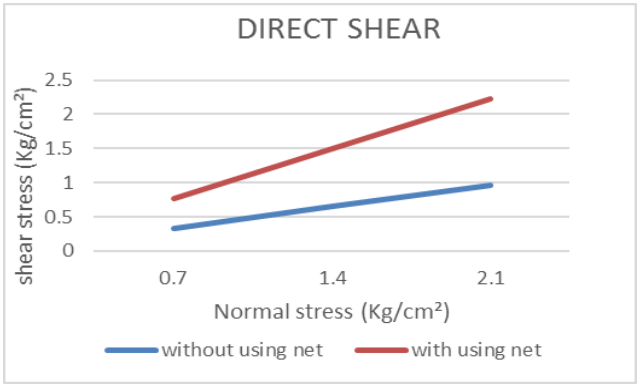

Figure 6: variation of shear stress with and without using mosquito net

Shear strength of soil after reinforcing:

$$\rightarrow S2 = \sigma.\tan 31$$

So the increase in the shear strength of the soil is obtained by:

$$\frac{S2 - S1}{S1}$$

$$\frac{\sigma.\tan 31 - \sigma.\tan 25.4}{\sigma.\tan 25.4} = 0.265$$

The increase shear strength of soil by using mosquito net as a layer at 2.5 cm from the top face is 26.5% approximately (fig.6).hence it is recommended to use this reinforcement technique in various construction activities to enhance to bearing capacity of the soil.

VI. CONCLUSION

From the above study of soil geo-synthetic interaction is presented by conducting direct shear test with sandy soil it was clearly observed that a significant change in the sliding friction of the soil sample which directly affects the shear strength of the soil sample. So by applying the mosquito net the sliding friction of the soil is enhanced by 22% which will directly influence the shear strength of soil increase by 26.5%. So the soil can transfer the loads safely and can be prevented from the failure.

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