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Research Article

STABILIZATION OF CLAY SOIL AND RED SOIL USING GEOSYNTHETICS

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A B S T R A C T

Geosynthetics are products of synthetic materials, it used to the process of stabilizing weak soil. They are normally polymeric products; it used to resolve the geo technical problems which occur during construction of roadways in expansive soils. In this research, the relative characteristics of red and clay soil reinforced with geosynthetics were experimented in natural condition and by reinforcing the soil using various Soil reinforcements by geosynthetics (Steel wool and Wire mesh was used as soil reinforcement. Reinforced Polyethylene was used as geotextiles. LDPE sheet and fibre glass membrane are used as geo membrane). The basic properties of soil were analysed in the laboratory under natural condition for clay and red soil. The geosynthetics are positioned at 1/3rd from the top, top surface and third condition is mixed sample. The strength parameter was determined using Unconfined Compressive Strength test for natural condition of soil. From the outcome of the experimental analysis, it was found that the strength is found to be improved by thorough mixing of Fibre Glass Geomembranes from 0.18 Kg/cm2 to 3.8 Kg/cm2 for red soil and by thorough mixing of LDPE sheet Geomembranes from 0.39 Kg/cm2 – 1.73 Kg/cm2 for clay soil.

INTRODUCTION

The performance of the soil in the designs depends upon the characteristics of soil. Therefore,the testing of soil with relative materials to the determination of its physical properties of given soil. The evaluation of effects of seepage conditions involves the very crucial part in the development of soil engineering. The role of reinforcement in affecting the behaviour of reinforced soil is influenced by factors such as form, surface properties, dimensions, strength and stiffness. Geosynthetics are artificial products which are used in the process of stabilizing weak soil. Geo synthetics depend on interfacial friction and bonding, besides interlocking effort, which develops when aggregates occupy the space in the apertures of the Geo synthetics. Brian O.Oyegbile (2017) studied the application of geosynthetics membranes in soil stabilization and safe guards the coastal areas. Refining the properties of soil, it could help in stopping the soil erosion due to natural and artificial threats.

The typical processes of stabilizing the soil were studied by various researchers based on various conditions with various materials. J.Kiran Kumar *et,al* (2019) have introduced E-waste as a soil stabilizer in order to strengthen the geotechnical properties of soil and also to lessen the abandoning of E-waste. Soil can also be stabilized with alternative materials based on the physical and chemical characteristics of that material.V on Maubeuge.K et.al (March2008) conducted an experimental investigation on the numerous types of geo grids with varying field conditions and also studied the various design issues and features of geo grids related to soil reinforcement. Jiaren Yu *et,al* (2020) assessed the possibility of using anhydrous sodium meta- silicate as geo polymer activators. This research showed that the anhydrous sodium meta-silicate powder samples had lower interim strength but a better rate of increase in the strength than the Sodium Hydroxide solution samples.

Omid Amini *et,al* (2019) observed the influence of magnesium slag and cement on improving stability of soil. The soil pores are sealed with the magnesium slag and cement mixture which leads to formation of denser mass between the particles and progress in the strength of soil. From the experimental study done by Nitin Tiwari *et,al* (2019), The tangible progress in the shear strength and bearing capacity of expansive soil subgrade was experiential with the addition of lime with coir geotextile.

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MATERIALS AND METHODS

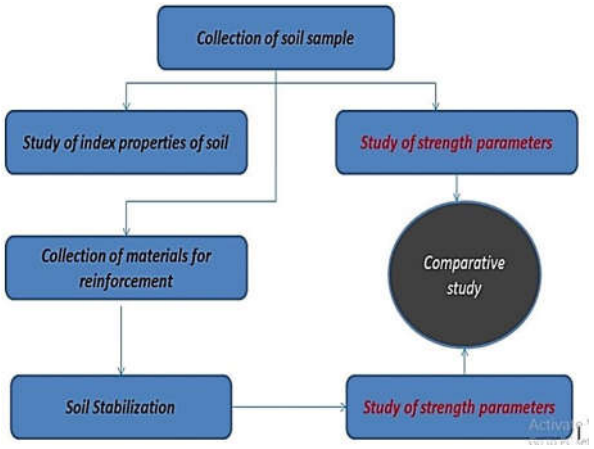


Fig 1 Methodology

Sample Collection and Preparation

The samples of red soil and clay soil were collected from Sundakkamuthur and Ganapathy, Coimbatore as per the sampling procedure. In each location three points are fixed at an interval of 5m. The samples taken from the fixed points are taken and mixed together for experimentation process.

Test samples are prepared in three soil reinforcement conditions i.e. Steel wool and Wire mesh was used as Geo grids. Reinforced Polyethylene was used as geotextiles. LDPE sheet and fibre glass membrane are used as geo membranes.

Soil Stabilization

In this study, the strength properties of ordinary red soil and clay soil was compared with the properties of red soil and clay soil reinforced with Geo grids, Geotextiles and Geomembranes. Geotextiles are generally pervious and lets the water to flow through it but, when it was incorporated with the soil, it had the ability to reinforce and protect the soil from instability.

Geo grids, Geotextiles and Geomembranes are man-made material which acts as impervious membrane to avoid the soil erosion. LDPE Geomembranes and Fibre glass Geomembranes are used as a liner in order to improve the stability of the red soil and clay soil. Geomembranes shown in the **Fig.2**are collected with the thickness ranging from 500 micron to 1000micron.

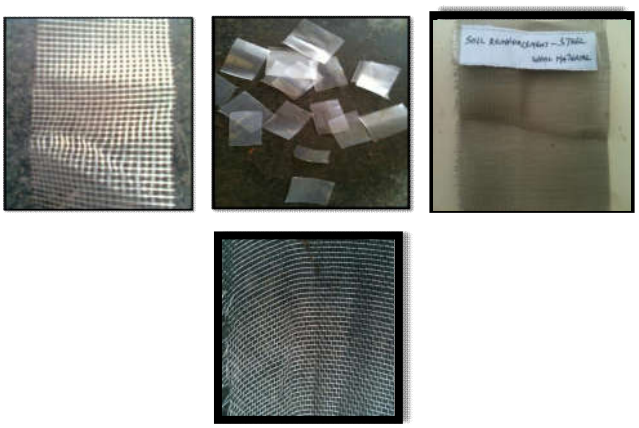


Fig 2 ***(a)*** *Fibre glass Geomembranes* ***(b)*** *LDPE Sheet Geomembranes* ***(c)*** *Steel Wool* ***(d)*** *Wire mesh.*

Experimental Program

The preliminary tests have done for the given soil sample to assess the stability of soil in multiple conditions. The soil samples are tested for various physical characteristics to determine the stability and integrity of red and clay soil under the following conditions.

Table I Specification of Soil Reinforcement

Sample Taken	Reinforcement Technique	Synthetic material used	Arrangement of Materials in UCC Mould
Red and Clay Soil Samples	Geo grids	Steel Wool	TopSurface One–Third Mixed aspieces
		Wire Mesh	TopSurface One–Third Mixed as pieces
	Geotextiles	Reinforced Polyethylene	TopSurface One–Third Mixed aspieces
	Geomembranes	Low Density Polyethylene Sheet	TopSurface One–Third Mixed aspieces
		Fibre Glass Membranes	TopSurface One –Third Mixed as pieces

The soil samples are prepared as per the stipulations given below in the **Table.1.** The samples were determined unconfined compressive strength as per the Indian Standards.

RESULTS AND DISCUSSION

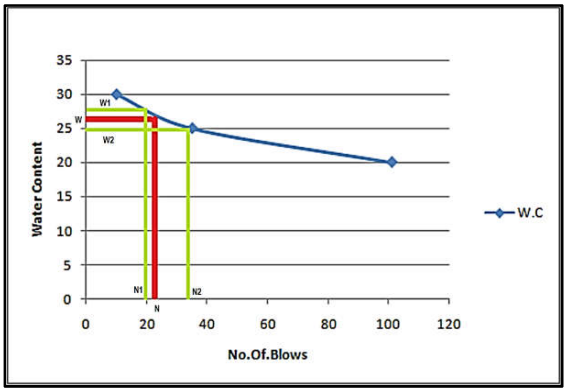
Atterberg Limits

The uniformity of a soil can be indicating its firmness might vary with the water content. The water content in the soil fluctuates from one state to another state. The manner of determining the limits between the different state of soil is termed as Consistency limits or Atterberg limits. Shrinkage limit (S), Plastic limit (P), and Liquid limit (L) of red soil & Clay soil was plotted in a graph as shown in **Fig.3**. Based on the laboratory test can be attained the limits.

Liquid Limit (L)

Liquid limit was determined by placing a red soil sample in liquid limit device and creating a groove by means of a spatula. The device was dropped till the separation disappears. The red and clay soil was dried and the optimum water content was determined.

The water content obtained from the red soil sample was 26.8 % and flow index was 12.34 and the water content obtained from the clay soil sample was 30.0% and flow index is 9.56.



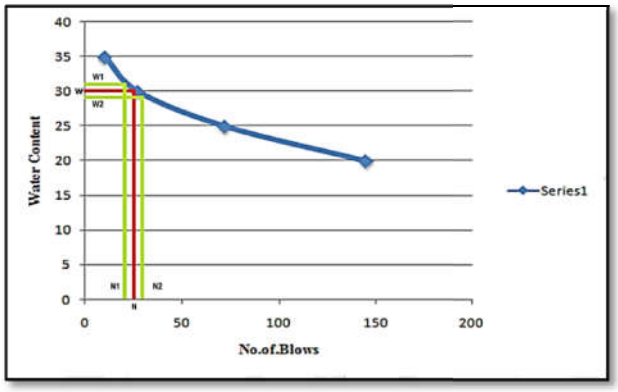


Fig 3 Liquid Limit of Red and Clay Soil Sample

Plastic Limit (P)

The corresponding critical moisture content is drives major role for attained the plastic state. It is termed as plastic. The weight of dried oven soil was expressed in percentage for the moisture content.

At this point, the soil losses its plasticity. The oven dried soil was weighted and the plastic limit of the red soil and clay soil was calculated.

From the **Table.2**, Plastic limit for red soil sample was 20% and clay sample was 40%.

Table II Plastic Limit of Red & Clay Soil Sample

Name of the sample	Empty Weight of Can And Lid (W_1) Gm	Weight of Can & Lid + Wet Soil (W_2)Gm	Weight of Can & Lid + Dry Soil (W_3) Gm	Plastic Limit (%)
Red Soil	48	54	53	20
Clay Soil	63	70	68	40

Shrinkage Limit (S)

It is the moisture of the soil for the given sample, when the water is adequate to seal all the voids of the soil and the soil is saturated. The volume will not reduce when the moisture is decreased under the shrinkage limit (S).

In this research, the shrinkage limit of the red & clay soil sample was determined as per IS2720. From the below Table 3,The shrinkage limit of the red soil sample was found out to be 16.54 % and clay soil sample was found out to be 8.23%.

Table III Shrinkage Limit of Red Soil Sample

Name of the sample	Wt. of empty petri glass dish (W_1) Gm	Wt. of petri glass dish + wet soil (W_2) Gm	Wt. of wet soil [$W_2 - W_1$] (W) gm	Wt. of dish + dry soil (W_3) gm	Wt. of dry soil [$W_3 - W_1$] (W_d) gm	Vol.of wet soil (V)	Vol. of dry soil (Vd)
Red Soil	40	88	48	75	35	22.57	16.54
Clay Soil	40	82	42	64	24	22.57	8.23

Unconfined Compressive Strength

Unconfined Compressive strength Test is a simple laboratory testing technique to measure the mechanical properties of fine-grained soils.

It delivers measures of the undrained strength and the stress-strain characteristics of the soil. In this study, the strength of the red soil sample imposed with various geosynthetics materials were tested and tabulated below.

From the Table.4, it was found that the strength of the red soil and clay soil reinforced with Geomembranes showed the improvement in stability of soil.

Table IV Results Obtained From Unconfined Compressive Strength of Red Soil & Clay Soil with Geosynthetics

Type of soil	Material used	Position	UCC OF SOIL (Kg/ cm^2)
Red soil	Geotextile (reinforced polyethylene)	1/3rd	1.25
		TOP	1.6
		MIXED	1.3
	Geo grids soil reinforcement (wire mesh)	1/3rd	1.8
		TOP	1.77
		MIXED	2.5
	Geo grids soil reinforcement (steel wool)	1/3rd	2.45
		TOP	3.4
		MIXED	3.65
	Geomembrane (ldpe sheet)	1/3rd	1.9
		TOP	2.1
		MIXED	2.5
	Geomembrane (fibre glass geomembrane)	1/3rd	3.3
		TOP	3.5
		MIXED	3.8
Clay soil	Geotextile (reinforced polyethylene)	1/3rd	0.95
		TOP	1.05
		MIXED	1.13
	geo grids soil reinforcement (wire mesh)	1/3rd	1.2
		TOP	1.36
		MIXED	1.48
	Geo grids soil reinforcement (steel wool)	1/3rd	1.35
		TOP	1.55
		MIXED	1.63
	geomembrane (ldpe sheet)	1/3rd	1.25
		TOP	1.66
		MIXED	1.73
	Geomembrane (fibre glass geomembrane)	1/3rd	1.45
		TOP	1.35
		MIXED	1.65

Red soil sample reinforced with Fibre glass Geomembranes showed the improvement in the stability and strength of the red soil sample and it was noticed that the stability for the red soil have improved when the geo synthetics materials are reinforced in mixed condition.

Clay soil sample reinforced with LPDE sheet Geomembranes showed the improvement in the stability and strength of the clay soil sample and it was noticed that the stability for the clay soil have improved when the geosynthetics materials are reinforced in mixed condition.

Comparison of results between Natural red soil sample and Reinforced red soil sample – mixed into pieces

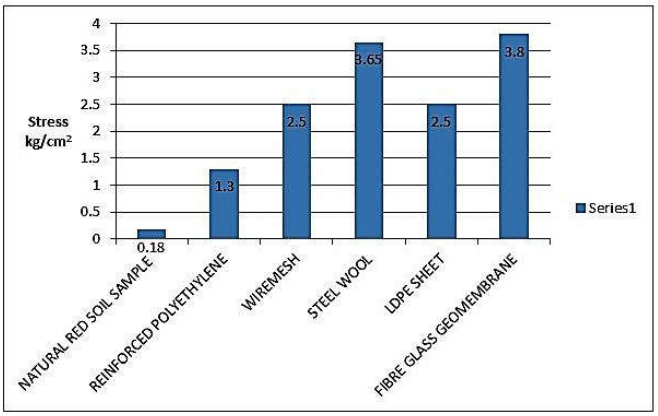


Fig 4 Comparison of Red Soil Sample with Reinforcement materials - Mixed into Pieces

Comparison of results between Natural clay sample and Reinforced clay sample – Mixed into pieces

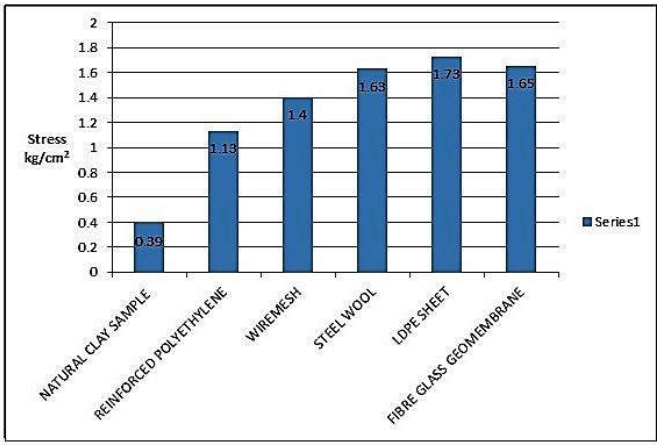


Fig 5 Comparison of Natural Clay sample with Reinforcement materials - Mixed into Pieces

CONCLUSION

- Stabilization of soil depends on the mechanical properties of the soil. The strength of the red soil sample was found to be increased by thorough mixing of Fibre glass Geo membranes from 0.18 Kg/cm^2 – 3.8 Kg/cm^2 for Red soil.
- The strength of the clay soil sample was found to be increased by thorough mixing of LDPE sheet Geo membranes from 0.39 Kg/cm^2 – 1.73 Kg/cm^2 for clay soil.
- From the overall study, it was noticed that the stabilization of red soil and clay soil was very much improved when the Geo synthetics materials are mixed systematically.

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