International Journal of Future Generation Communication and Networking
Vol. 13, No. 3, (2020), pp. 2912–2919

Evaluating The Strength And Deformation Characteristics Of A Reinforced Geotextile Bag Layer On Soft Soil.

P Shivananda
Professor, School of Civil Engineering,
REVA University, yelahanka-560064
Bengaluru, Karnataka, India
p.shivananda@reva.edu.in

Vinay B K
M.Tech student, School of Civil Engineering,
REVA University, yelahanka-560064
Bengaluru, Karnataka, India

Abstract
Geotextiles have been successfully used for reinforcement to improve the strength of soft soil. In this paper the one layer of geotextile bags(filled with soft soil) are used to improve stength of soft clay soils. Laboratory load deformation tests were performed to investigate the Stress-Strain behaviour of unreinforced and one layer geotextile bags on soft clay soils. In this studies one layer of geotextile bags are placed at top 1/5th height within soil sample. As soft clay soil used having only cohesion (Ø=0) the increase to pseudo-confining effect is due binding force by cohesion property of soil and geotextile bags that increased the Strength. To further increase strength of reinforced system of soft soil by increasing pseudo-confining effect, 1/5th layer is provided with non plastic sand layer (Ø soil) with and without geotextile bags layers. The result of these tests shows that, strength of reinforced soft soils increases as pseudo-confining effect increases.

Keywords: *Strength, Geotextile bag, pseudo-confining effect Soft soil, Reinforced soft soil,*

Introduction

Reinforce soil is the one of the geotechnical ground improvement strategy has been utilized from ancestors time and it is additionally drilled in our collective of animals. A portion of the landmarks in our history likewise give us the verification that soil reinforce is being utilized over hundreds of years. To rehearse it in field, numerous reinforce materials are accessible for the reinforcement of weak soft soil, well known these days are the geosynthetics.

Agreeable execution of road relies upon the sub level soil condition. In the event that the sub level soil comprise of delicate soils, quality and strength of road asphalt lessens. Strengthening soil is one of the a powerful and dependable method for improving quality and dependability of soils. Subsequently Geo manufactured are frequently used to improving the CBR of feeble/weak sub grade soil for paved and unpaved roads. Which Reduces the profundity of miss happening (grooves), Improved load bearing limit and frost up hurl Extend the administration life and diminish the expense of by and large development. A few specialists have indicated the advantages of geo manufactured in pave and un-pave road over weak sub soil level to improve their presentation. Increase in strength of sub grade soft soil that is to increase the CBR values when reinforced with geo synthetics depends on the properties and type of geo synthetics, depth and number of reinforcement layers [1]. Bearing capacity of soft soil can be increased and reduce settlement under external loads by Soil bag reinforcement with the reused excavated soft soils as the contained material [2] and also depends upon different sizes of geo bags, as well as number and arrangement of geo bags h [3]. The strength and stiffness of soil increases with different types of geo synthetic reinforcement concluded by [4] , [5] and [6]. For low-volume roads with relatively thin pavement sections, correctly selected geotextiles gives benefits for separating the sub grade and base course minimizing pumping, filtering infiltrated/ground water, and stabilized the road [7].

ISSN: 2233-7857 IJFGCN

Objective

- Laboratory test was conducted to determine strength and deformation by using single layer Geo textile bag as reinforcement with in Soil sample.
- To evaluate CBR value of Unreinforced Soft Clay Soil , and reinforced by single Geo textile bag layer in top 1/5th height.
- To evaluate CBR value of Unreinforced Soft Clay Soil with top layer replaced by Non Plastic sand, and reinforced by Geo textile bag layer in top 1/5 of layer.
- To evaluate CBR value of above cases by compacting statically with 833kg (1/3 of Equivalent static load) and 5000 kg (Twice the Equivalent static load).

Materials used

Soil

The soil utilized for the tests are typically accessible soft soil and non plastic soil obtained from Reva university, Bangalore. By conducting grain size analysis and Atterberg limit tests as per IS : 2720. The soil is classified as low plasticity clay (CI) and silty sand (SM). In **fig 1** shows the particle size distribution curve of soft soil. laboratory determined engineering properties of soft soil in are shown in table 1.

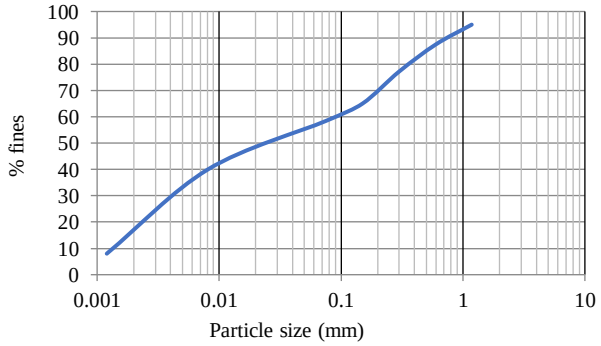

Figure 1: Particle size distribution of soft soil

Table 1a: engineering properties of soft soil

Sl no	Details	Soft Clay Soil	Non plastic soil
1	% Gravel	0	0
2	% Sand	41.5	78.9
3	% Silt and clay	58.5	22.1
4	Liquid limit	38.8	NP
5	Plastic limit	26	NP
6	Plasticity index	12.8	NP
7	Soil Classification	CI	SM
8	MDD in gm/cc	1.50	1.89
9	OMC in %	15	6
10	CBR Value In %	0.88	8.35

Geo textile bag.

Woven Geo textile used are manufactured from polyester or polypropylene (which are polymers obtained by condensation polymerization of carboxylic acid and diol or by propylene). synthetic

ISSN: 2233-7857 IJFGCN

fibres are weaved to textiles, geo textile bags are more flexible, low biodegradation susceptible, high premeable liquid flow. These are suitable for applications involving the functions of separation, filtration and stabilisation. It has excellent resistance to biological and chemical environments normally found in soils and it is stable against short-term exposure to ultraviolet radiation. which is low cost and soft, geotextile material are made to single geo bags of dimension (7.5*3*1cm). Each bags are filled with two different types of soft soil and non plastic soil weighing 110 grams.

Figure 2: Geo textile bags filled with soil

Table 1b : Properties of geo textile bag.

Geosynthetic	Description	value	unit
Geo textile layer	Mass per unit area	40	g/m^2
	Material size	7.5cm*3cm*1cm	cm

Methodology

The standard proctor test were conducted to determine maximum dry density (MDD) and optimum moisture content (OMC) as per IS : 2720 (part 7) 1980. Results shows MDD of 1.50 gm/cm^3 and OMC of 15 gm/cm^3.

Un-soaked California bearing ratio test was conducted on soft soil without reinforcement and with two layer of geo textile layer reinforcement as per IS: 2720 (part 16) 1973.

To know the strength and deformation of geo textile bags reinforced soft soil, the increasing pseudo confining effect are known, geo textile bags were placed at top $1/5^{th}$ height with in soil sample and by providing non plastic sand layer at $1/5^{th}$ layer with and without two layer or geo textile. By Two different loads of static compaction effort.

Equivalent static load required to achieve standard compaction maximum density is 2500kg.

- In this study compaction is carried out statically by two loads. ($1/3^{rd}$ of static equivalent load and twice the static equivalent load)
- 833kgs and 5000 kgs

Purpose of using static load compaction

- This can be applied easily by using compression testing machine. Static compaction does not disturb or cause damage the placed geo textile bags, because of the gradual movement of piston.

Cylindrical mould is replaced by 15×15×15 cm concrete cube mould. A cylinder mould has two circular faces without edges or vertices .where as cube mould is having 4 faces with 4 corners with a

ISSN: 2233-7857 IJFGCN

angle 90º are adopted for test, as geometry of pavement structure are similar to cube. Geo textile bags of each dimension 7.5×3×1cm are arranged in a mould that there is no any free lateral movement of bags under continuous loading conditions as shown in **fig 3**. By knowing maximum dry density (MDD) and optimum moisture content (OMC) the required dry weight of soil to mould volume is known and water is added to soft soil mixed well,

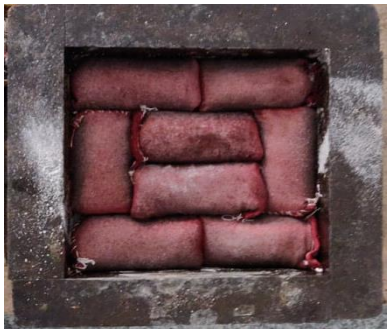

Figure 3: Arrangement of geo textile bags

Case 1 : Soft Soil is filled in mould by 5 layers with out reinforcement and by providing single layer of geo textile bag as reinforcement at top 1/5th layer.
Case 2 : soft soil is filled in a mould by 4 layers with placing non plastic sand layer at 1/5th layer without and with reinforcement by bags. Study on Both the case were conducted at two different types of static compaction load. The position of placed geo synthetic layer as shown in cross section model **fig 4**. Surcharge load were placed to stimulate the road construction thickness effect over test specimen. Load applied to the soil at rate 1.25mm/min. Load readings are noted at penetration of 0.5mm to 12.5 mm.

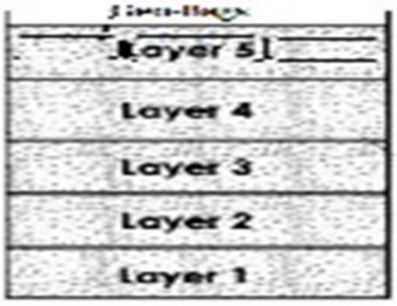

Fig 4: Schematic representation of test specimen with reinforcement by geo bags at top 1/5th layer

Table 2: CBR values at 833kg of static compaction

Types	2.5 mm penetration	CBR (%)	5mm penetration	CBR (%)
Soft soil	2.75	0.88	4	0.85
Soft soil+ Geotextile bag	5.1	1.63	8	1.71
Soft soil + non plastic soil	6	1.92	8.5	1.81
Soft soil+ non plastic soil+ Geotextile	14	4.49	20	4.28

ISSN: 2233-7857 IJFGCN

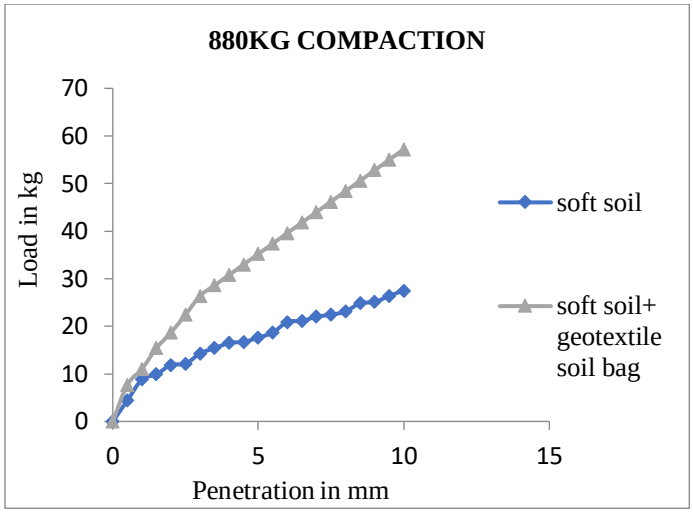

Figure 5 : Load v/s penetration curve at 833 kg compaction

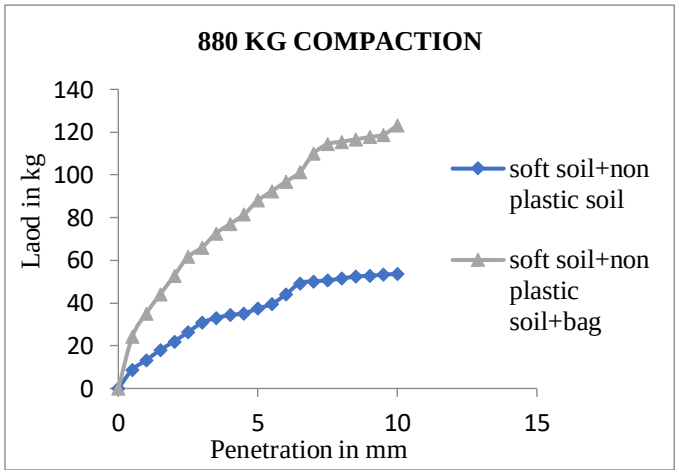

Figure 6: Load v/s Penetration curve at 833 kg compaction

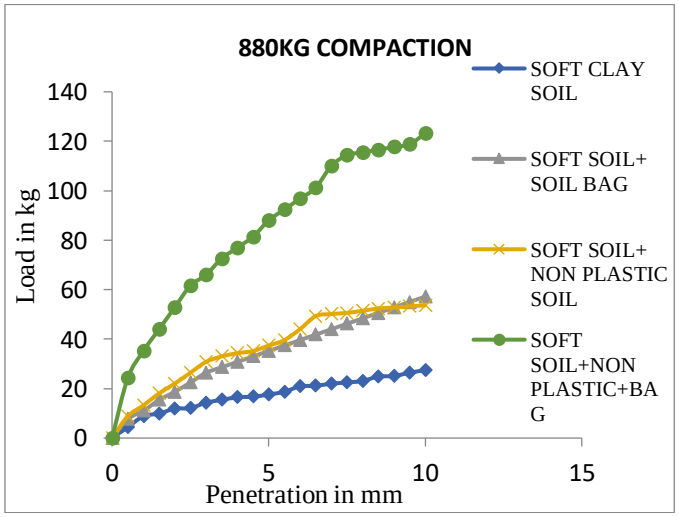

Figure 7: Load v/s Penetration curve at 833 kg compaction

From fig 5,6&7 represents the variation in the load v/s penetration curves from the CBR tests for unreinforced and reinforced section with single geo textile bag layer. It is observed that placing geo

ISSN: 2233-7857 IJFGCN

textile bags filled with soft soil at top 1/5th with in soft soil and bags filled with non plastic sand placed at top 1/5th by replacing one layer of soft soil by non plastic layer. The increase in cbr value depends upon external force generate tensile force in a soil bag leads to confinement effect of geo bags [3] and static compaction efforts.

CBR value at 833 kg compaction of unreinforced soil specimen corresponds to 2.5mm and 5.0mm penetration were 0.88 and 0.85% respectively as shown in fig 5, which were increased to 1.63 and 1.71% respectively, when soft soil is reinforced with bags filled with soft soil. The fig 6 represents unreinforced soft soil replacing top layer by non plactic soil corresponds to 2.5mm and 5.0mm penetration were 1.92 and 1.81%, where increased to 4.49 and 4.28%, when geo bags reinforced in non plastic layer. Further by increasing compaction from 833 to 5000 kg as shown in fig 8-10, Gives higher CBR value.

Table 3: CBR values at 5000 kg of static compaction

Types	2.5 mm penetrat	CBR (%)	5mm penetratio	CBR (%)
Soft soil	6.5	2.08	8.5	1.81
Soft soil+ Geotextile	14	4.49	23	4.92
Soft soil + non plastic	14	4.49	20	4.28
Soft soil+ non plastic soil+Geo textile bag	19	6.10	28	5.99

Fig8: Load v/s Penetration curve at 5000 kg compaction

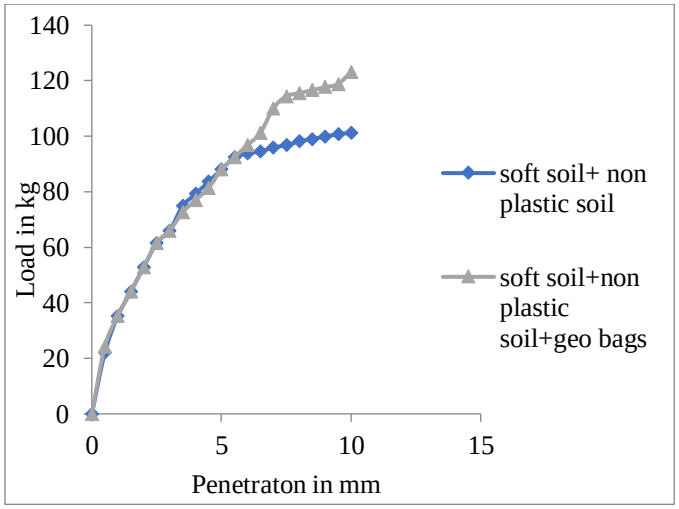

Fig 9: load v/s penetration curve at 5000 kg compaction

ISSN: 2233-7857 IJFGCN

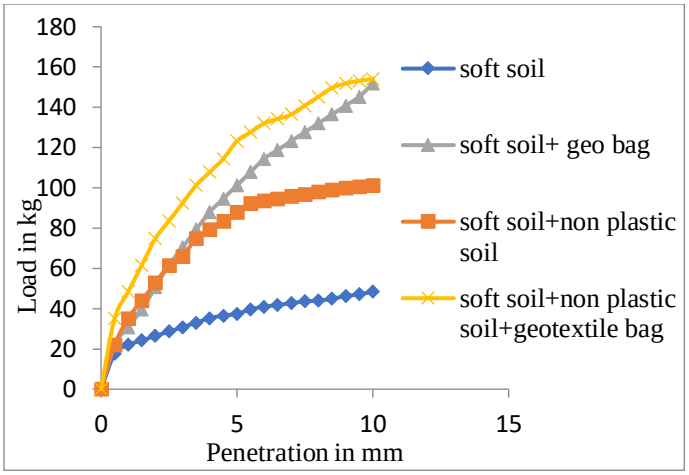

Figure10: Load v/s Penetration curve at 5000 kg compaction

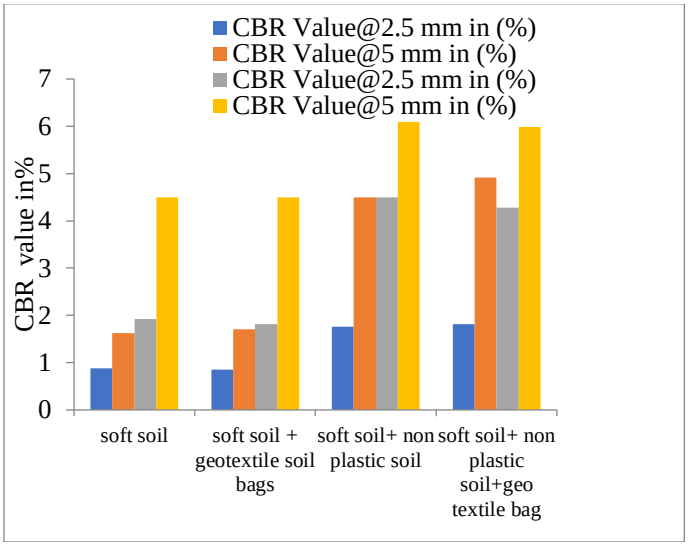

Figure11: Represents CBR value in % at compaction load of 833kg and 5000kg

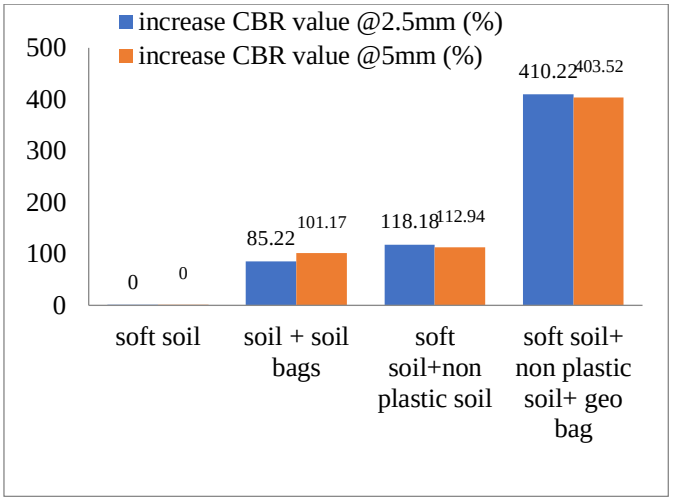

Figure 12 : Represents increase in CBR value with respect to unreinforced soft soil at 833kg compaction

ISSN: 2233-7857 IJFGCN

Result and discussion :

From above **fig:12**

- Soft Clay Soil, By providing single Geo-textile bag as reinforcement in top 1/5th layer increase CBR Value 85.22% and 101.17% times.
- Soft Clay Soil, 5 layers replacing top one layer with non- plastic soil, shows increase in CBR value 118.18% and 112.94%.and By providing Geo textile bag as reinforcement in top $1/5^{th}$ non plastic layer, shows further increase CBR Value 410.22 & 403.52%.
- By Increase initial compaction effort from 833 kg to 5000Kg further increases CBR Value in all the above cases as shown in the increment % bar chart.
- From economical view Geo textile used to reinforce soil are very cheaper cost material.
- Further we can improve the strength of the soil by using greater strength and stiffness geo textile material.

Conclusion:

From present study,

1. By proving single Geo-textile bag as reinforcement in top 1/5th layer increase CBR Value of Soft Clay Soil
2. By replacing top one layer of Soft Clay Soil (out of 5layes) by Non Plastic Soil with providing Geotextile bags as reinforcement in top 1/5th layer further increase CBR Value.
3. Due to confinement of geotextile-bags gave better performance CBR value in soft soil and soft soil with non plastic soil layer.
4. By Increase initial compaction effort from 833 kg to 5000Kg further increases CBR Value in all the above cases.
5. By replacing top one layer (out of 5 layers of soft soil) with single Geotextile-bag layer with Non Plastic Soil in sub grade soil, increase the CBR value by 410 % and reduces pavement thickness as per IRC 37. And this a economical and feasible solution for ground improvement.

References

[1] Meenakshi singh et al : "Strength enhancement of the subgrade soil of unpaved road with geosynthetic reinforcement layers" Transportation Geotechnics 19 (2019): pp. 54–60

[2] Liujiang Wang et al : "Field load tests and modelling of soft foundation reinforced by soil bags" Geo synthetic international (2019) 26(6): pp 1-36.

[3] Nader Hataf et al: "Experimental and numerical study on the bearing capacity of soils reinforced using geobags" Journal of Building Engineering 15 (2018): pp. 290–297.

[4] K . Rajagopal et al **:** "Studies on geosynthetic-reinforced road pavement structures" International Journal of Geotechnical Engineering 2014 vol 8 no 3: pp 287-289.

[5] Madan Neupane et al: "Experimental and Analytical Evaluations of Mechanically-Stabilized Layers with Geogrid over Weak Subgrade under Static Loading" Geo-Congress (2020) GSP 316 Feb 25–28 © ASCE : pp. 597-606.

[6] Hoe I. Ling et al: **"** performance of geo synthetic reinforced asphalt pavements" The Journal of Geotechnical and Geo environmental Engineering, Vol. 127, No. 2, February, 2001. ©ASCE, pp 177-184**.**

[7] Saad Ullah et al : "Evaluation of the Long-Term Performance of Woven Geotextile Used between Base Course and Subgrade of a Paved Road" transportation Research Record,(2019) vol. 2673, 8: pp. 310-321.

ISSN: 2233-7857 IJFGCN