International Journal of Research in Engineering, Science and Management
Volume-3, Issue-8, August-2020
journals.resaim.com/ijresm | ISSN (Online): 2581-5792 | RESAIM Publishers

Strengthening of Weak Subgrade Using Geo Nailing Technique

S. M. Rashmi[1], R. Suhas[2*], D. Ravi Kiran[3], P. S. Darshan[4], A. Tharun[5]
[1]*Assistant Professor, Department of Civil Engineering, JSS Academy of Technical Education, Bangalore, India*
[2,3,4,5]*Student, Department of Civil Engineering, JSS Academy of Technical Education, Bangalore, India*
*Corresponding author: suhasr774@gmail.com

***Abstract*: Soil is naturally occurring materials that are used for the construction of all pavement layers except the surface layer of the pavement. Proper treatment of problems in soil conditions and the preparation of the foundation are extremely important to ensure a long-lasting pavement structure that does not require excessive maintenance. The current study was conducted on weak subgrade soil (black cotton soil) which is having more clay or silt content. Based on the concept of soil nailing technique, in this investigation an attempt is made to increase the CBR value and load bearing capacity of the black cotton soil by introducing geo nails. Geo nails are cone shaped friction piles made of no fines concrete which will be driven into the soil at appropriate depth and lateral spacing.**

***Keywords*: Black cotton soil, California bearing ratio, Geo nailing technique, No fine concrete.**

1. Introduction

The soil subgrade is a layer of natural soil prepared to receive the layers of pavement materials placed over it. The loads on the pavement are ultimately received by the soil subgrade for dispersion to the earth mass. The weak subgrade whether in cut or fill should be well compacted to utilize its full strength and to there by economize the overall thickness of the pavement required. But in case this supporting layer does not come up to the expectations, the same is treated or stabilized to suit the requirements. The subgrade becomes weaker with the existence of “Expansive soil (Black cotton soil)”. Compacted soil and stabilized soil are often used in sub-base or base course of highway pavements. Expansive soils are soils or soft bedrock that increases in volume or expand as they get wet and shrink as they dry out. In India this Expansive soil is called ‘black cotton soil’. The subgrade soil and its properties are important in the design of the pavement structure. The main function of subgrade is to provide sufficient stability uber adverse climatic and loading conditions. If roads are built on poor subgrade soil deformations can occur, thus which increase maintenance cost and lead to interruption of traffic service. Geo-Nailing is a one of the cost-effective subgrade improvement technique. Geo-Nails are cone shaped friction piles made up of no fines concrete of suitable proportion. the geo nails are casted by varying their length and mean diameter. These geo nails are introduced into the soil and California bearing ratio test has been conducted for each different mean diameter and length of the geo nail.

2. Literature Review

A very few research works have been done on geo nailing technique for strengthening of weak subgrade soil. An innovative Geo nail system for soft ground stabilization has been proposed by Y. M. Chenga et al., (2012), the low cohesion of the soft clay equates to small bond strength between the ground and the soil nail, which results in a low pull-out resistance of the soil nails. Meanwhile, it is usually not cost effective to improve the pull-out resistance by increasing the length of the soil nails due to the limitations at the construction site.

Based on the research by J. Ranjitha and M. R. Rajasekhara, Black Cotton Soil is very weak in nature and is not preferred as subgrade soil. The present study, however, is aimed at using alternate and comparatively low-cost technique to stabilize the Black Cotton Soil. The soil nailing concept is carried out in order to enhance the strength of Black Cotton subgrade soil and minimize settlement. It is Concluded that CBR value increases and improving the load settlement characteristics of black cotton soil with the insertion of no fines concrete nail.

Chin (1975) [12], Stated that expansive soils in Mississippi were recognized in mid-19th century by E.W. Hilgard of soil science. He observed that certain clayey soil has tendency to crack in dry seasons and form large surface cracks 2 to 3-inch-wide, which were injurious to vegetation and building. Hilgard commented that most brick and stone building in Jackson, not secured by wall anchors or concrete foundations, developed cracks in all direction over time.

SK Au, A. M Pearson, N. Li., (2012) states that the Geo nail system is introduced and the verification of this system as accomplished through trial tests and in-situ tests is explained in detail. Geo nails serve dual purposes, stabilization and ground improvement A.P Ambily & S.R Gandhi (2004), S.N Maravizhi worked on strengthening of soil using stone columns. Poulos H G. (1976), Tuozzolo, T.J. (1997) worked on the behaviour of piles including dimension and lateral spacing. Y. K. Shiu and G. W. K Chang has worked on the effects of inclination, length pattern and bending stiffness of soil nails on behavior of nailed

structure.

3. Objective of the Study

- To study the properties of weak subgrade soil.
- To make optimum usage of low-cost material like no fines concrete cones to obtain better strength of the subgrade.
- Effect of size of no fine's concrete nails on Subgrade strength of the soil.
- Comparison of properties of weak soil with geo nails driven soil.
- To provide a permanent solution for subgrade failure in rural areas.

4. Methodology

For the present work the weak soil (Black Cotton soil) was procured from Ranibennur taluk, haveri district, Karnataka. The soil was taken from a depth of 1.5 meter from the natural ground level. The obtained soil was dried and pulverized.

Geo nails are concrete cones casted with no fines concrete. No fines concrete is used in order to obtain the rough surface which induces the friction when inserted into the soil and converts applied into frictional stress. It is referred by different names including zero-fines concrete, pervious concrete and porous concrete. In this study 53 grade cement and coarse aggregate which is passing 20mm and retained on 10mm sieve is used.

Table 1
Dimensions of no fines concrete cone

Cone. No.	Top Diameter, cm	Bottom Diameter, cm	Height, cm
1.	5	2	5
2.	6	2.5	8

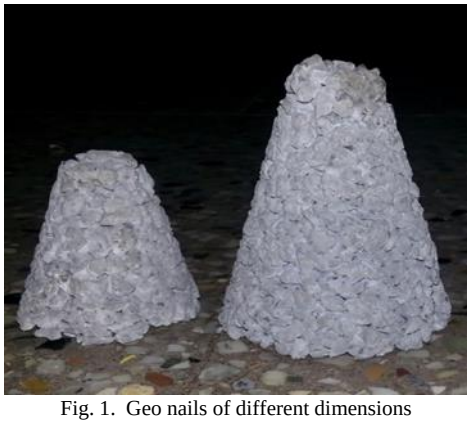

Fig. 1. Geo nails of different dimensions

For CBR test, static compaction procedure is carried out.6kg of soil sample is thoroughly mixed at OMC The CBR mould is filled in 3 layers with each layer being tamped 56 times. The center portion of the soil filled in the mould is excavated to the size of the no fines concrete nail and it is then inserted. This procedure is repeated for each size of the nail.

5. Experimental Study

The laboratory studies conducted to study the basic properties of the soil is as given in table 2.

Table 2
Properties of Black cotton soil used in study

S. No.	Experiments	Results
1.	Specific gravity	2.35
2.	Liquid Limit	80%
3.	Plastic Limit	42.5%
4.	Plasticity Index	37.5%
5.	Shrinkage Limit	22.22
6.	Optimum Moisture Content	28%
7.	Maximum dry Density	1.41g/cc

6. Results and Discussions

A. *California bearing ratio (CBR)*

Table 3
CBR Values

Particulars	Specimen condition	CBR Value
Black cotton soil (Normal soil)	Unsoaked	2.48
	Soaked	1.58
Geo nail-1	Unsoaked	2.94
	Soaked	2.03
Geo nail-2	Unsoaked	3.39
	Soaked	2.7

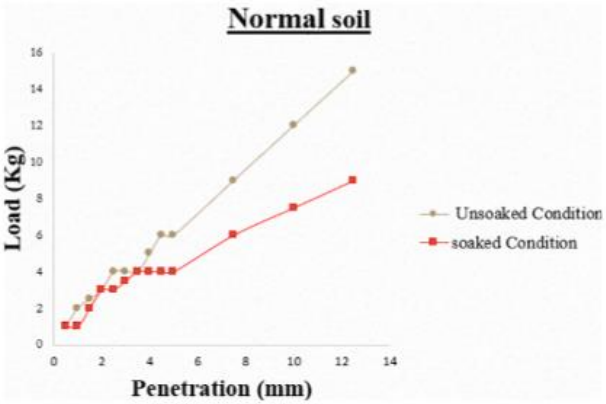

Fig. 2. CBR (%) of Black Cotton Soil

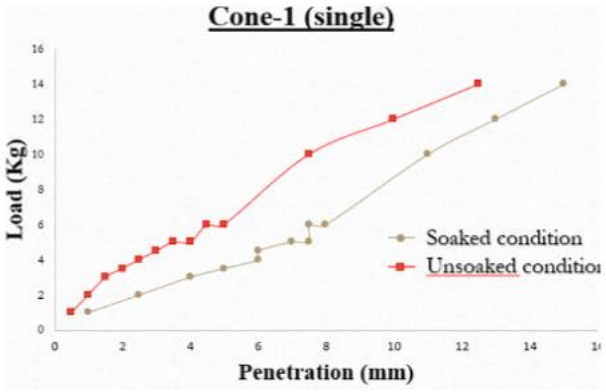

Fig. 3. CBR (%) of BC soil encased with cone-1 (single)

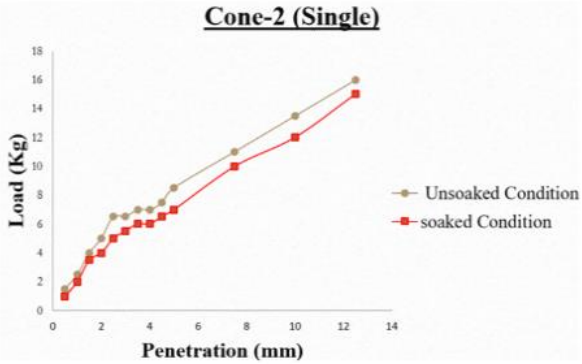

Fig. 4. CBR (%) of BC soil encased with cone-2 (single)

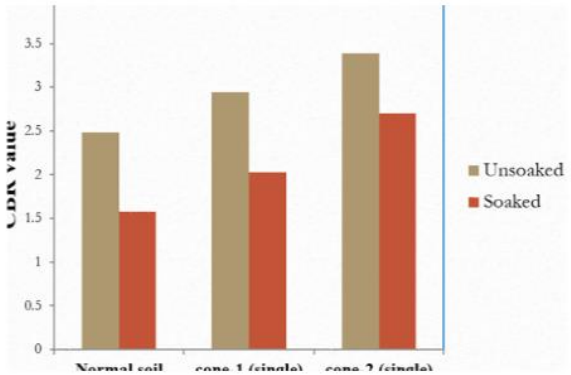

Fig. 5. Relation between CBR values of normal soil and geo nails

7. Conclusions

- Using principle of geo-nailing technique, it is possible to transfer higher vertical load without shear failure.
- Encasing of geo-nails into soil improves the CBR values and also the load carrying capacity of black cotton soil depending on the size and number of geo-nails.
- The CBR value gradually increases with the insertion of geo-nail and but decreases in the soaked condition.
- The type of material, shape, size, tapering angle and group efficiency of geo-nails plays on important role in the load transfer capability.
- No fines concrete which comparatively less strength than normal concrete is effective for load settlement characteristics of Black cotton soil when used as geo nails.
- Based on the results it can be concluded that g geo-nailing technique can be used more effectively for clayey soil (soft clay).

References

[1] Y. M. Chenga, SK Au, A.M Pearson, N. Li. “An innovative Geonail system for soft ground stabilization,” Vol. 10, Dec. 2012.
[2] J. Ranjitha, M. R, Rajashekara, “Subgrade improvement using no fines concrete nails”, IJRET 2018.
[3] Pradeep Singh, K. S. Gill, “CBR Improvement of clayey soil with geo-grid reinforcement,” Vol. 2, Issue 6, June 2012.
[4] Poulos H. G, “Behavior of Laterally Loaded Piles Nears Cut or Slope,” Australian Geo mechanics, Vol. 6, No. 1, pp. l-12, July 1976.
[5] Poulos H G, “Analysis and design of piles through embankment”. Design and construction of deep foundation, Vol. 3, pp. 1403-1412, December 1994.
[6] Chin, (1975) “Problems in black cotton soil.”
[7] BIS 2720 (Part I) 1983, “Preparation of Dry Soil for Various Tests”, Second revision, New Delhi.
[8] BIS 2720 (Part II) 1973, “Determination of Water Content”, Second revision, New Delhi
[9] BIS 2720 (Part 5) 1985, “Determination of Liquid Limit and Plastic Limit”, Second revision, New Delhi.
[10] BIS 2720 (Part8) 1983, “Determination of Water Content-Dry Density Relation Using Heavy Compaction”, Second revision, New Delhi
[11] BIS 2720 (Part 16) 1987, “Laboratory determination of CBR”, Second revision, New Delhi.
[12] S. K. Khanna, C. E. G. Justo & Veeraghavan, “Highway Engineering Principle and laboratory manual,” revised 5th edition 2009.
[13] B. C. Punmia, “Soil Mechanics and foundation,” 16th edition 2006.