Embedding Root Reinforcement Using Vetiver Grass in Laterite Soil

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Abstract- *Soil bioengineering is an environmentally friendly method which employs vegetation to reinforce the soil. Vegetation is regarded as a new engineering material contributes to slope stability and reduces superficial soil erosion, both by soil shear reinforcement and influencing soil water content. The vegetation can contribute to slope stability in two ways, mechanical and hydrological. This paper demonstrates the effect of a vegetation root matrix on a soil slope and focuses on mechanical reinforcement using an example of vetiver grass. It is found that addition of root in the soil matrix not only improves the stability of the soil but also helps in various other parameters and hence its highly suggested that vetiver roots can also be used as soil reinforcing agents.*

Keywords- vetiver roots, shear strength, compressive strength, Permeability

I. INTRODUCTION

The use of ground cover plants to overcome the slope failure was widely practiced throughout the world. This study investigates the effect of soil reinforcement using plants roots on the shear strength, and compressive strength of soil. The tests that carried out are classified into two categories: First, tests on soil without reinforcement and second tests on soil with reinforcement. The loading test was conducted on small scale model using different layers of reinforcement. The results showed that the shear strength parameters could be improved by using plants roots reinforcement. Moreover, the shear strength, and compressive strength of soil are increased by using plants roots. The vegetation materials may reduce soil erosion and runoff, create space for breeding and habitat and they are commonly used in river ecological engineering. Therefore, it is important to select the soil bioengineering plant by taking its growth characteristics and the soil solidity of its root system as the major considerations. Many studies on vegetation-reinforced soil have been carried out including laboratory shear tests on soils with plant roots. Several indirect methods are available to estimate the increased strength of the soil due to the presence of plants, including the pull-out test. The uprooting resistance force provides valuable information on the role of root hairs in anchorage. The lateral pulling test was used to simulate a certain bamboo failure during a landslide and also was used to ascertain the resistance the vetiver grass root system can provide when torrential runoffs and sediments are trying to uproot the plant. In particular, the aims of the study were 1) to investigate the plant's bio-mechanical aspects and 2) to verify whether root reinforcement and the field rooting ability of stem cuttings enhance its potential for use in slope stabilization and soil bio-engineering.

II. MATERIALS AND METHODS

The study focused on this typical Mediterranean species. It consists of the spatial distribution of its roots and the statistical variability of RAR at each depth. Root tensile strength tests were carried out using devices that were custom-built in our faculty laboratories.

The plants had grown in a local nursery and had been transplanted with their root balls, when the slope was being restored.

Root collection

Root collection is done by removal of the sub soil using soil removal tools without affecting the soil surrounding the roots of the plants, the plants are then covered in plastic sheets and transported to the laboratory carefully without affecting the root-soil mass. The roots are then separated only in the required quantity; the remaining portion is watered to keep the plants alive until the testing is completed. This method allowed the roots to continue growing during the portion of the experimentation.

The vetiver plant species that are selected for the root reinforcement studies are collected from Mannuthy Agricultural University (Thrissur, Kerala) and the laterite soil is collected from chittilippilly panchayat.

III. RESULTS AND DISCUSSION

Tests were conducted as per Indian standard test procedure, the shear strength test is conducted with shear

controlled undrained pattern, Unconfined test is conducted in the stress controlled, undrained pattern. Permeability and hydraulic characteristics were obtained using falling head permeameter. Plant roots in single aspect ratio is used throughout the study, the length and the diameter of the root is measured using digital Vernier caliper. the roots are washed and immersed in water for at least 3-4 hours before addition of fibers in the soil. The soil- root matrix is prepared by using hand mixing to enable through mixing of the roots across the soil matrix. The soil is kept is specially designed soil mould which enabled undisturbed soil testing. The results obtained were given in table 1 whichshows the variation of strength and hydraulic parameters with and without addition of roots.

TABLE1: PROPERTIES OF SOIL

Properties	Result
Uniformity coefficient(C_u)	13.66
Coefficientof Curvatures(C_c)	1.17
Liquid limit(%)	40
Plastic limit(%)	20
OMC(%)	14
Permeability(mm/sec)	0.0654
Shear strength(N/cm²)	4.44
UCC(N/cm²)	4.04
Specific gravity(G)	2.67

A. Optimum moisture content with and without root

It is found that the addition of 2-4 % of roots by weight in the soil affects the OMC value and increase it to 10% from 11%. This is a considerable increase in terms of water quantity required to compact the soil, this is mainly attributed to the larger surface area of the roots which absorbs more water during the mixing and maturation. This also increases the weight of root mass and hence provides more stability and strength to the soil- matrix.

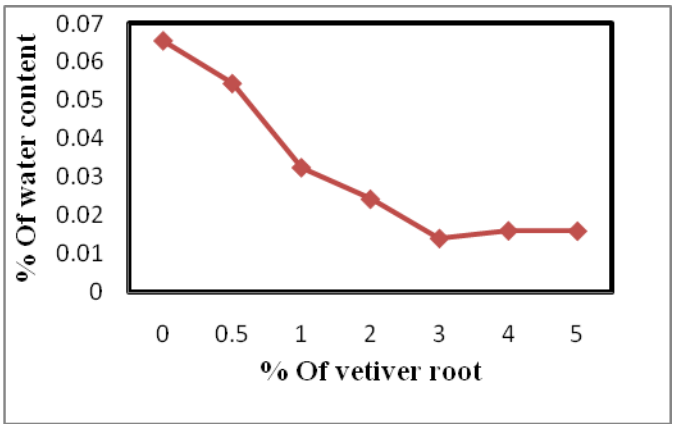

Fig 1. Effect of OMC with the addition of various percentage of Vetiver Root

B. Shear strength with and without root

It is found that there is considerable increase of shear strength is obtained with the increase of root mass in the soil. The shear strength is studied in undisturbed soil samples and hence it can be ascertained that the shear strength increase is purely attributed to the roots tensile strength and the root bio mass

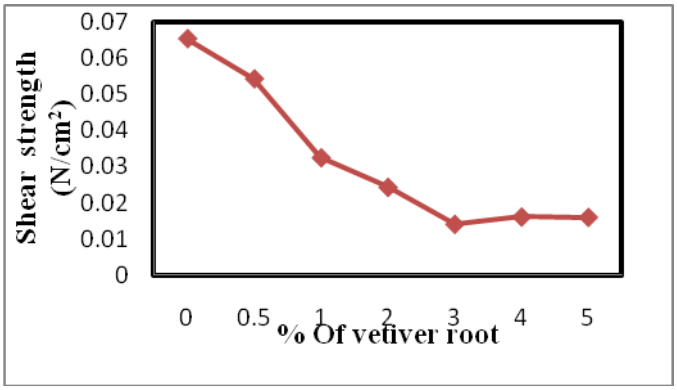

Fig 2.Effect of shear strength with theaddition of various percentage of vetiver root

C. Unconfined Compressive Strength with and without root

It is found that The UCS increased with increasing root content in the soil The UCS of the soil with 4% root content almost doubled that of the natural soil sample.

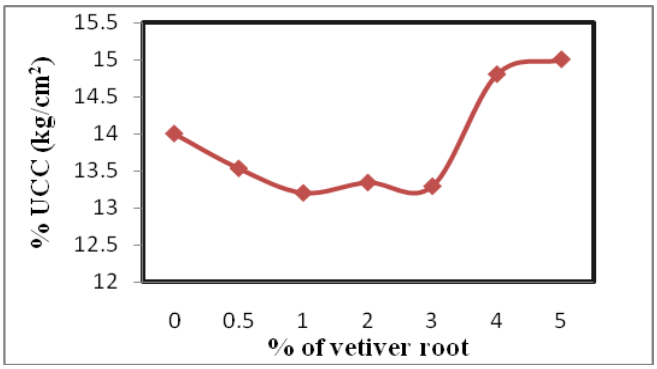

Fig 3.UCC with additional of various percentage of vetiver root

The predominance of sand in the soil (with only about 16% clay present) can attribute to the generally low UCS and cohesive force with the particles of the nature soil.

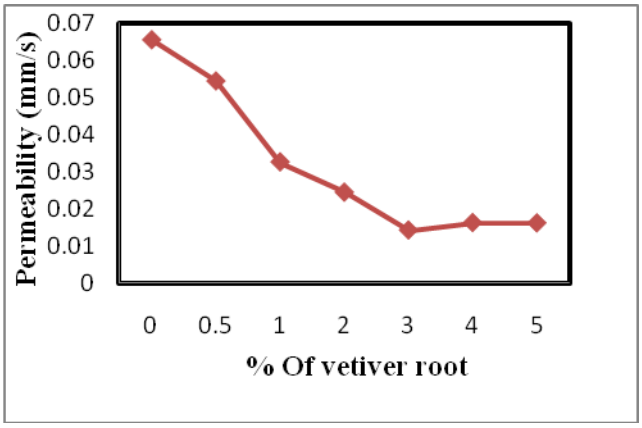

Fig 3. Effect of permeability with theaddition of various percentage of vetiver root

IV. CONCLUSION

This study shows that the addition of roots as a root matrix is aviable solution for increasing both strength and stability characteristics. As the increasing root content, the permeability of the soil steadily found to be decreasing. It is found that the roots add up more reduction in the permeability other than densification of soil. Also it is found that the roots take up some amount of water added in the soil particles and thus results in increased OMC values in higher root percentage, with the increase of root content in the soil. Shearing resistance grows steadily as the roots creates a fiber matrix and with the increase in matrix density, the variation of fibers the strength value steadily increases. Therefore, vetiver roots are seen to have a great effect on the strengthening of the surface soil where the root length and the radius of root bundle are generally high.

REFERENCES

[1] Hengchaovanich, D., Nilaweera, N., 1998. An assessment of strength properties of vetiver grass roots in relation to slope stabilization. In: Proceedings of the First International Conference on Vetiver. Office of the Royal Development Projects Board, Bangkok, pp. 153–158

[2] Greenfield, J.C., 1996. Vegetative vs. mechanical soil conservation system as they affect moisture conservation and sustained production. In: Proceedings of the First International Conference on Vetiver. Office of the Royal Development Projects Board, Bangkok, pp. 1–7

[3] S.B. Mickovski, L.P.H. van Beek, Root morphology and effects on soil reinforcement and slope stability of young vetiver (Vetiveria zizanioides) plants grown in semi-arid climate, Plant Soil, 324 (1-2), 43-56, (2009)

[4] N. Pollen-Bankhead, A. Simon, and R.E. Thomas, The reinforcement of soil by roots: recent advances and directions for future research. Treatise on Geomorphology, 12(8), 107-124, (2013).

[5] Bestun J. Nareeman and Mohammed Y. Fattah (2012), 'Effect of Soil Reinforcement on Shear Strength and Settlement of Cohesive-Frictional Soil', Int. J. of GEOMATE, Vol. 3, No.1, pp. 308-313.

[6] Ying Liu, Jiarong Gao, Huipin Lou, Jinrui Zhang and Qiang Cui (2011), The root anchorage ability of Salix alba var. tristis using a pull-out test,' African Journal of Biotechnology, Vol. 10(73), pp. 16501- 1650