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USE OF VETIVER GRASS FOR SOIL STABILISATION

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Abstract: Soil bio-engineering is the idea of using plant resources, especially the strength of its roots, to stabilise the weak soil, such as natural and man-made slopes. This approach is utilised widely throughout the world and is also being applied in India. Ecologists conduct the majority of the study on soil bio-engineering, whereas geotechnical research in India on using plant roots as reinforcement is still in its early stages. By stabilising the soil with roots from plants that are common in the area, attemptes are made to analyse the strength variation in a landslide-affected soil. A certain root mass is put into the soil together with the roots after which the altered geotechnical properties are confirmed. It has been discovered that adding roots to the soil matrix not only increases the soil's stability but also benefits many other factors. As a result, it is strongly advised that vetiver roots be employed as soil-reinforcing agent.

Keywords: Vetiver Grass roots, shear strength, compressive strength, optimum moisture content, soil stabilization, fly ash, permeability, bio-engineering.

1. INTRODUCTION

This study examines how employing vetiver grass roots to strengthen soil affects the soil's shear and compressive strengths. The experiments that were conducted are divided into two groups: first, tests on unreinforced soil, and second, tests on reinforced soil. A small size model was used for the loading test, and various reinforcing layers were used. The outcomes demonstrated that vetiver grass roots could increase the shear strength parameters. Additionally, employing plant roots improves the soil's shear and compressive strengths.

The vegetative materials are frequently utilised in river ecological engineering because they can prevent soil erosion and runoff and provide habitat and breeding grounds. Therefore, it is crucial to choose the soilbio-engineering plant while taking into account its development traits and the soil solidity of its root system. There have been numerous research on soil reinforced by vegetation, including laboratory shear tests on soils with plant roots. The pull-out test is one of several indirect techniques that can be used to calculate the increased soil strength brought on by the presence of plants. Information on the function of root hairs in anchoring is valuable from the uprooting resistance force. The lateral pulling test was employed to determine the resistance the vetiver grass root system may offer while torrential runoffs and sediments are attempting to uproot the plant, as well as to simulate the failure of a specific bamboo during a landslide.

2. MATERIALS REQUIRED

A. SOIL

Minerals, organic materials, gases, liquids, numerous species, and minerals get combined in soil to support life on Earth. A natural body known as the pedosphere i.e. soil serves four crucial

purposes: it serves as a substrate for plant growth, a way to store, supply, and purify water; it modifies the atmosphere of Earth; and it serves as a habitat for species, all of which in turn affect the soil.

B. VETIVER GRASS

Vetiver, sometimes referred to as Khus grass, is a perennial grass that originated in India. The plant is drought tolerant and has vast, finely textured fibrous roots that are helpful in preserving soil and water. Vetiver oil is produced on an annual basis in excess of 300 tonnes worldwide, with only 20–25 tonnes coming from India. Haiti, India, Java, and Reunion are the principal producers in the globe.

TYPES OF VETIVER

Vetiveria zizanioides L. and V. nigritana are the two types of vetiver utilised for soil conservation. The latter is native to Southern and West Africa, and because it produces viable seeds, its application should be restricted to those regions of the continent where it is found. In south Asia, two genotypes of V. zizanioides are employed for soil and water conservation:

- The genotype of north Indian wildflowers and seeds.
- South Indian genotypes with sterility or very low fertility.

3. STABILISATION

A. PURPOSE

The most common application of stabilisation is in the construction of road and airfield pavements, where the main goal is to increase the strength or stability of soil and to reduce the construction cost by making the best use of locally available materials. Stabilisation is defined as the various methods employed for modifying the various properties of soil to improve its engineering properties for engineering works.

B. PRINCIPLES OF STABILISATION

Natural soil is a material that is both complex and varied. However, due to its widespread accessibility and inexpensive cost, it presents excellent prospects for skillful usage as an engineering material. Though it doesn't happen often, the soil in a specific location may not always meet the needs of the construction engineer. Therefore, it is necessary to decide whether to:

- Accept the site's content as it is and design it to suit the limitations set by its current quality.

OR

- To replace the existing site content with something better to change the characteristics of the current soil to produce a new site material that can better match the task's needs.

The last option is referred to as "Soil Stabilisation," which involves changing the soil's characteristics to satisfy particular engineering criteria.

C. METHODS OF STABILISATION

The soil stabilising techniques can be divided into two categories:

i. Improvement or modification of the existing soil's qualities without the use of admixtures. For example, soil's natural shear strength, compaction and drainage.
ii. Property modification with the aid of admixtures. For example, mechanical stabilisation and stabilisation using chemicals, bitumen, fly ash, lime, and cement.

I. LIME STABILIZATION

Lime is a cost-effective method of stabilising soil. In contrast to the cementing effect carried on by pozzolanic reaction, an increase in strength brought on by cation exchange capacity is referred to as lime modification (Sherwood, 1993). Clay soils become drier and less sensitive to changes in water content (Roger et al, 1993). A pozzolanic reaction in which pozzolana minerals react with lime in the presence of water to form cementitious compounds is referred to as lime stabilisation (Sherwood, 1993, EuroSoilStab, 2002). Either quicklime (CaO), or hydrated lime (Ca(OH)2), can produce the desired result. In dry soil situations where water may be needed to accomplish adequate compaction, slurry lime can also be employed (Hicks, 2002).

II. CEMENT STABILIZATION

Cement has been used as a binding agent since the 1960s, when soil stabilisation technology was first developed. Because it can be used by itself to produce the necessary stabilising action, it may be regarded as a main stabilising agent or hydraulic binder (Sherwood, 1993; EuroSoilStab, 2002). The main role of cement reaction is its reaction with water, which can be present in any soil, and is not dependent on soil minerals (EuroSoilStab, 2002). This may be the rationale behind the widespread usage of cement in soil stabilisation. There are several different varieties of cement available in the market, including regular Portland cement, cement from blast furnaces, sulfate-resistant cement, and high alumina cement. Typically, the final strength sought and the type of soil to be treated determine the cement to be used. The cement reaction takes place during the hydration process. The process begins when cement is combined with water and other ingredients for a specific application, which causes a phenomenon known as hardening. Cement will encapsulate soil as glue when it has hardened (set), but soil structure won't be altered (EuroSoilStab, 2002).
In most cases, a tiny amount of cement is applied, but it is enough to enhance the soil's engineering qualities and the cation exchange of the clay. These enhanced qualities apply to soils that have been stabilised by cement:

- lower cohesiveness (Plasticity)
- reduced compressibility or volume expansion
- enhanced strength (PCA-IS 411, 2003).

III. FLYASH STABILIZATION

As a byproduct of coal-fired electric power plants, fly ash has inferior cementing qualities to lime and cement. The majority of fly ash comes from secondary binders, which by themselves are unable to provide the desired effect. However, it can chemically react with a small quantity of activator to create cementitious compound, which helps strengthen the strength of soft soil. Fly ash is easily obtained, less expensive, and environment friendly. Fly ashes can be divided into two categories: class C and class F. (Bhuvaneshwari et al, 2005, FM 5410). Sub-bituminous coal combustion results in Class C fly ash, which has significant cementing characteristics because to its high free CaO level. Because Class C from lignite has the highest CaO (over 30%), it exhibits self-cementing properties (FM 5-410). Anthracite and bituminous coal are burned to create Class F fly ash, which has low self-cementing capabilities since there isn't much free CaO available to help clay minerals flocculate. As a result, it needs to be activated with cement or lime.
The following restrictions apply to fly ash stabilization of soil:
- The soil that needs to be stabilised must have less moisture, therefore dewatering can be necessary.
- When cured below zero and subsequently submerged in water, soil-fly ash mixture is extremely prone to slaking and strength loss.

4. OBJECTIVES

- To better the soil's stability, it is important to understand its current state and its unique properties. In addition to being a good soil binder, vetiver also aids in preventing soil erosion on steep slopes.
- By comparing the vetiver approach to other known soil stabilisation techniques while utilising several vetiver species to stabilise the soil.
- To determine soil strength using the vetiver stabilisation method.

5. LITERATURE REVIEW

A. Grimshaw et.al., 1994

For a very long time, vetiver grass (Vetiveria zizanioides) has been used in various nations all over the world to lessen soil erosion. It is commonly known that, when planted appropriately, vetiver grass's root qualities can aid in reducing soil erosion and boosting slope stability. When

vetiver hedge rows are grown across soil slope, the soil particles cannot pass through and the terraces that form between the hedges increase the stability of the slope. The physical characteristics of the root and their qualitative significance for erosion control and slope stability have been clarified by some prior studies on vetiver.

The ability of vetiver to firmly anchor themselves onto soil slope profiles and the early development of its deeply penetrating, fibrous root structure are highlighted. The strength characteristics of vetiver root, which also play a significant role in slope stabilisation and erosion management through their affects on the shear strength of soil slope, are still not fully understood. The root creates tension when a plant root crosses a possible shear surface in a soil profile; the component of this tension tangential to the shear zone directly resists shear, while the normal component raises the confining pressure on the shear plane. Therefore, while considering a plant species as a component in slope stability, it is crucial to ascertain the tensile root strength properties.

B. Erocon Sdn Bhd, 1997

Two-year-old vetiver plants planted on an embankment slope were sampled for mature roots to determine the tensile root strength. The specimens were tested in fresh condition limiting the time elapsed between the sampling and the testing to two hours maximum. The 15-20 cm long straight and unbranched root samples were secured to a holder at one end and vertically connected to a hanging spring balance at the other end using a wooden clamp. The holder was manually pushed down until the root failed. The maximum load was observed at failure.

The results of end sheared samples and those with unusually altered rupture sites were deleted after the mode of failure for each sample was reviewed. Since the bark failed before the root due to its lower strength qualities, the root diameter without bark was utilised to compute the tensile root strength before the total tensile stress travelled to the root core. The ultimate tensile force and tensile strength in relation to root diameter without bark were determined by testing about 80 vetiver root specimens of various diameter classes ranging from 0.2 to 2.2 mm.

6. RESULTS AND ANALYSIS

a) COMPACTION TEST

Soil	Before vetiver Plantation	After 1 month of plantation	After 3 month of plantation
Compaction (%)	96.0	96.5	97.3

b) SHEAR STRENGTH

Soil	Before vetiver Plantation	After 1 month of plantation	After 3 month of plantation
Shear Strength (kPa)	14.7	15.3	15.8

c) OPTIMUM MOISTURE CONTENT

Soil	Before vetiver Plantation	After 1 month of plantation	After 3 month of plantation
O.M.C. (%)	12.3	12.7	13.1

d) PERMEABILITY TEST

Soil	Before vetiver Plantation	After 1 month of plantation	After 3 month of plantation
Permeability (mm)	139	138.9	138.6

7. CONCLUSION

According to this study, growing roots as a root matrix is a practical way to improve both strength and stability properties. With the development of roots, it has been seen that the soil's permeability gradually decreases. This naturally leads to greater density and shearing resistance. In order to confirm the accuracy of the loss in hydraulic characteristics, the study was done with variable growth, and it was discovered that, in addition to densifying the soil, the roots also contribute to a greater reduction in permeability. Additionally, it has been discovered that the roots absorb some of the water that has been supplied to the soil particles, leading to higher root percentages and higher OMC values. This is consistent with the findings of other researchers who used a variety of other natural soil roots to increase shearing resistance.

Shearing resistance increases steadily as root content in the soil rises. Roots produce a fibre matrix, and as matrix density and fibre variation rise, so does the strength value. The main issue that may arise when roots are grown is that, after a certain amount of time, the roots degrade in the soil. However, this situation occurs with all kinds of roots that are inserted into the soil. Humus may be created as a result of the combined degradation of the soil-root matrix, which could increase stability.

REFERENCES

1. 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. 16501-16507.

2. David F. Polster, M.Sc. R.P.Bio. (2009), „Soil Bioengineering Treatments for Degraded Riparian Ecosystems," Polster Environmental Services Ltd.5953 Deuchars DriveDuncan, B.C., Vol. 9, pp. 1-5.

3. Preti F. and Giadrossich F. (2009), "Root reinforcement and slope bioengineering stabilization .

4. Abdi E., (2014), „Effect of Oriental beech root reinforcement on slope stability (Hyrcanian Forest, Iran)", Journal of Forest Science, Vol. 60(4), pp. 166–173.

5. Patrik Peeters L., Leen De Vos, Bart Vandevoorde, Jentsje van der Meer (2013), Application of Grass Cover Failure Models Following in Situ Wave Overtopping Experiments in Belgium‟, Universal Journal of Geoscience.
6. Hamed fathi, Mojan mirzanejad, Ali Ebadi, Hossein moradi, Hesam Aryanpour (2014), Effects of wastewater irrigation on the growth of two bean spices and soil chemical properties under greenhouse conditions‟, International Journal of Soil and Crop Sciences, Vol. 2(2), pp. 033-038.
7. Yangming Luo, Depei Zhou, Junyun Zhang. (2012), ‟The Study on Stability Mechanism of Red Bed Slopes withEco-protection in the Southwest of China‟, International Conference on Ecology, Waste Recycling, and EnvironmentAdvances in Biomedical Engineering, Vol.7.
8. Normaniza Osman, Mohamad Nordin Abdullah & Che Hassandi Abdullah. (2011), ‟Pull-Out and Tensile Strength Properties of Two Selected Tropical Trees,‟ Sains Malaysiana, vol. 40(6), pp. 577–585.
9. Kurt S. Pregitzer, jared L. Deforest, Andrew J. Burton, Michael F. Allen, Roger W. Ruess, and Ronald L. Hendrick. (2002), „fine root architecture of nine north american trees‟, Ecological Monographs, vol. 72 (2), pp. 293-309.
10. J.E., Howell J.H. (1992), ‟Development of bioengineering strategies in rural mountain areas,‟ Erosion, Debris Flows and Environment in Mountain Regions (Proceedings of the Chengdu Symposium, July 1992), IAHS Publ. no. 209.

