JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Study and Analysis of Soil Stabilization using Sand, Cement and Geotextile materials

[1]Prof. Nikhil Ingale, [2]Kaustubh Pawar, [3]Vidyesh Garate, [4]Affan Sherkhan,

[5] Viphin Gangula

[1]Assistant Professor, [2,3,4,5] Students
[1,2,3,4,5] Department of Civil Engineering,
[1,2,3,4,5] Rizvi College of Engineering, Bandra, India

Abstract: Soil is a loose mixture of mineral and organic matter found in the upper part of the earth's crust. It is a natural product formed as a result of the weathering of rocks. Land is a product of nature and its characteristics may differ from region to region. Due to massive population growth, urbanization and rapid industrialization, we can only build on limited land such as landfills and areas close to water tables. Therefore, in these conditions of the ground, it is necessary to examine the geotechnical field of the soil. This study aims to investigate the effectiveness of using this information to increase bearing strength of soil, focusing on increasing stability, strength and durability in construction. Through laboratory tests, field studies and numerical simulations, this research evaluates the impact of sand-cement mixtures and geotextile materials on soil behavior. There are several known ways to achieve the above goals; One of them is the use of geosynthetics. When the geosynthetic layer is placed, it acts as support and provides additional durability to the soil. Tests such as Atterberg limit test and incremental test were performed to determine the properties and load capacity of the soil after the addition of geosynthetics. This study focuses on understanding the interaction between soil and stabilizers in order to provide recommendations for improving ground stabilization practices in various engineering projects.

***Index Terms* - Stability, Depth of foundation, Reinforcement, Settlement.**

I. INTRODUCTION

Soil stabilization is a procedure where the soil's physical properties are enhanced so as to improve its strength, durability, etc., through blending or mixing with additives. The following are various methods used for soil stabilization: Cement Stabilization of Soil, Lime Stabilization of Soil, Bitumen Stabilization of Soil, Chemical Stabilization and Geotextiles and Geo-synthetic fibres (a new technology in stabilizing soils).

The research and analysis regarding sand, cement and geotextile materials used in soil stabilization is significant in civil engineering and geotechnical engineering. For example, the techniques used for stabilizing soil aid to improve the engineering features; thus, making them appropriate for building activities like roads, foundations, embankments and retaining walls. Sand cement and geotextile materials introduced into the ground can help tackle problems associated with poor load bearing capacity as well as erosion and instability.

II. AIM & OBJECTIVE OF STUDY

The main objective is to reduce settlement and ensure long term structural integrity for roads, foundations and other civil engineering structures built on sand.
To control erosion in sandy soils by stabilizing slopes, embankment and shorelines.

III. Review of Literature

Resham and Vaishali Gupta (2019) paper titled "Improvement in bearing capacity of soil," published in the International Journal of Latest Research in Science and Technology, offers a comprehensive overview of various techniques aimed at enhancing the bearing capacity of soil. The review synthesizes existing literature on soil improvement methods, providing insights into their effectiveness and applications in geotechnical engineering practices.[1] M.S. Dixit and K.A. Patil (2010) performed a study on the "Effect of different parameters on bearing capacity of the soil". They collected samples from Paithan, Aurangabad, and Ellora and labeled them as soil 1, 2, and 3, respectively. They considered factors such as shape, depth, width of footing, and water table. They have concluded that: The important parameters that govern the bearing capacity of the soil are cohesion, unit weight of soil, depth of the proposed foundation, width of the foundation, and angle of internal friction.[2] Michael T. Adams and James G. Collins (1997) performed a test and published a research paper named “Large model spread footing test on geo-synthetic reinforced soil foundations”, in which they placed geo-synthetic reinforcement at a certain depth to assess its effectiveness and applied loads incrementally. The result clearly demonstrated that the geo-synthetic reinforcements can substantially increase the bearing capacity of shallow-spread footings on sand.[3] Chakrabarty S, Bhandari G, and Adak N (1997) published the paper "Performance of model footing on compacted PFA, jute reinforcement overlaying soft clay.". The paper examines the performance of a model footing on a combination of compacted PFA (pulverized fuel ash), jute reinforcement, and soft clay. The authors likely investigated the behavior and stability of this specific combination, analyzing factors such as load-bearing capacity and settlement. The paper's findings can provide valuable insights into the effectiveness of using jute reinforcement and compacted PFA in improving the performance of footings on soft clay soils.[4] Binquet J. and Lee KL (1975) published a paper titled "Bearing capacity tests on reinforced earth slabs," in which they investigated the bearing capacity of reinforced earth slabs. A study aimed to evaluate the strength and load-carrying capacity of reinforced earth slabs. The authors conducted various experiments and tests to determine the performance of these slabs under different conditions. The findings of this study provide valuable insights into the behavior and design of reinforced earth slabs.[5]

IV. METHODOLOGY

There are various methods to stabilize soil such as Geotextile Method, Compaction, Bio-Vegetation & Lime Stabilization. The methods are explained below in short:

Geotextile Method: Geotextiles offer a versatile and effective way to improve soil stability in a variety of engineering applications. These synthetic materials are designed with special properties suitable for collecting, separating, filtering and preserving soil. Geotextiles include woven or non-woven fabrics made of polypropylene, polyester or other polymers and are used in soil stabilization projects to increase the mechanical strength of soil and reduce erosion. In general, the geotextile method provides a good and effective solution for soil stabilization by providing engineers with a variety of tools to solve various problems in civil and environmental engineering projects. Soil stabilization can improve in situ, or natural state, soils eliminating the need for expensive remove-and-replace operations.

Compaction: Soil compaction is a fundamental process in geotechnical engineering that involves increasing the density of soil by reducing air voids and rearranging soil particles. This results in improved soil strength, stability, and load-bearing capacity. Here's a short note on the compaction of soil: Soil compaction is a mechanical process commonly employed in construction projects such as roadways, embankments, foundations, and earthworks to enhance the engineering properties of soil. It involves the use of compaction equipment, such as rollers and vibratory compactors, to apply mechanical force and reduce the volume of void spaces within the soil mass.

Bio-vegetation: Plant biology, also known as plant biology or biological biology, refers to the collection of plant life in an area. This all-encompassing concept includes many types of plants, including grasses, shrubs, trees and other plants. Biological plants play an important role in many ecological processes and functions such as soil stabilization, water retention, nutrient cycling and carbon sequestration. It also contributes to biodiversity and ecosystem resilience by providing habitat and nutrients for many organisms. The composition and structure of biological plants are affected by factors such as climate, soil type, topography and human activities. Therefore, different regions offer different types of biological vegetation, from dense forests to grasslands, from dry deserts to tundra.

Lime Stabilization: Lime stabilization is a technique used in construction and soil engineering to improve the properties of soil, particularly its strength and durability. It involves the addition of lime, typically in the form of quicklime (calcium oxide) or hydrated lime (calcium hydroxide), to soil to modify its chemical and physical characteristics. Lime stabilization is commonly used in road construction, foundation engineering, landfill construction, and remediation of contaminated soils. However, its effectiveness depends on factors such as soil type, lime dosage, mixing technique, and curing conditions. Therefore, careful analysis and testing are essential to ensure optimal results when employing lime stabilization techniques.

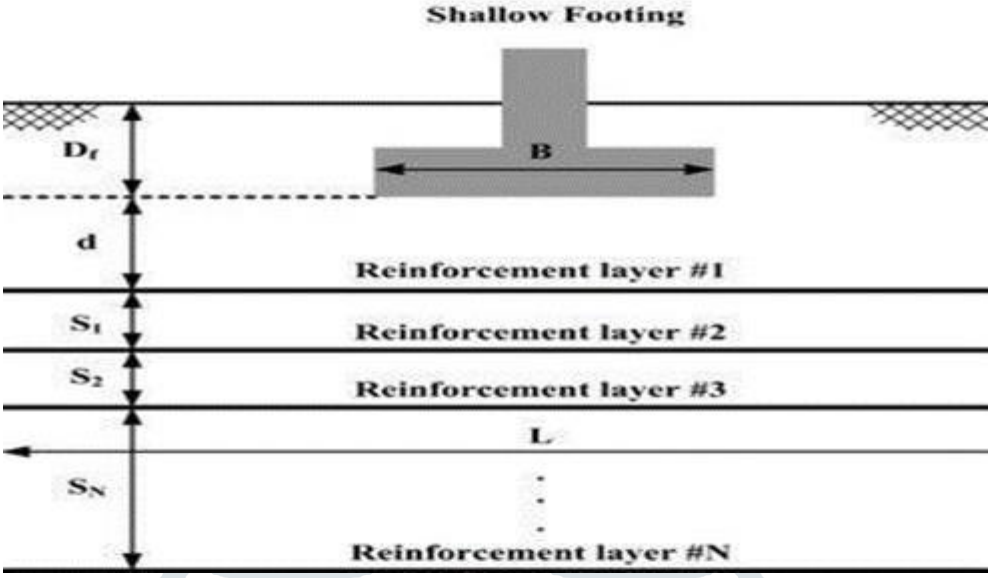

Fig. 4.1: Typical geotextile-reinforced soil system.

Fig. 4.2: Laboratory model test

Fig. 4.3: Experimental setup of load test

4.1 Properties of materials used

Cement: Ordinary Portland Cement 43 Grade conforming to IS 8119-1989 was used in the project.
Sand: Sieved from 300 µm and retained to pan.
Geo-jute: Two-dimensional woven geosynthetic material

4.2 Experimental Study

Test performed:

1. **Liquid Limit**
2. **Plastic Limit**
3. **Shrinkage Limit**
4. **Incremental Load Test**

Three samples of mix design 1:6, 1:4 & 1:3 are used in each of the above experiments. The liquid limit testing process involves adjusting the cup drop to 1cm and mixing 30g of air-dried soil with water to form a paste. After maturation, a portion is placed in the cup, a groove is cut, and the device handle is turned while counting blows until the soil flows. The water content is adjusted, and the process is repeated to determine the liquid limit. Similarly, for plastic limit testing, 30g of soil is mixed with water to form a paste, rolled into threads, and kneaded until crumbling. For shrinkage limit testing, a soil sample is mixed with water, placed in a shrinkage dish, dried, and weighed to determine mass changes.

For testing on unreinforced soil, a rectangular foundation model is placed in the center of a prepared test bed, with dial gauges at each end to record settlement. Loads are applied gradually, starting from a minimum, while monitoring the dial gauges for settlement readings. Once settlement stabilizes, additional loads are applied until the base is driven into the sand. After completion, the gauges are removed, and the tank is prepared for the next tests.

When soil is reinforced, sand is poured to the desired thickness, followed by layers of geosynthetic material and sand until the tank is filled. Load application and settlement monitoring proceed as before, with adjustments made for the added reinforcement layers. Figures depict the setup and testing system.

4.3 Results and Discussions

Sample No.	Cement Proportion	Sand Proportion	Water Content %
A	1	3	33.84
B	1	4	33.33
C	1	6	35.71

Table 4.1: Liquid Limit Results

Sample No.	Cement Proportion	Sand Proportion	Water Content %
A	1	3	26.5
B	1	4	26.9
C	1	6	28.6

Table 4.2: Plastic Limit Results

Sample No.	Cement Proportion	Sand Proportion	Water Content
A	1	3	19.8
B	1	4	20
C	1	6	20.7

Table 4.3: Shrinkage Limit Results

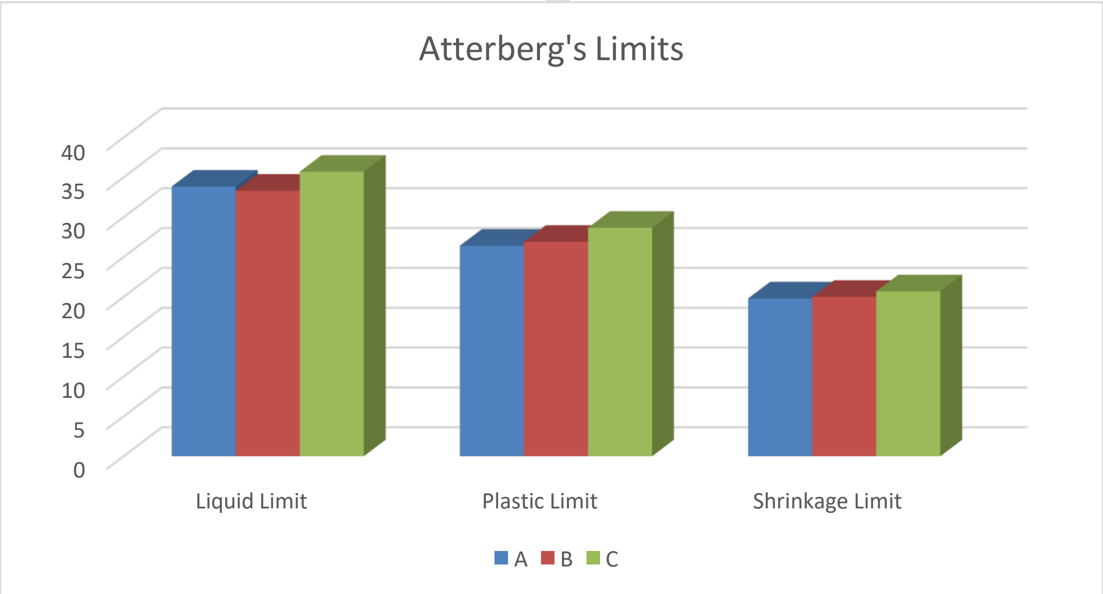

Fig. 4.4: Comparison of water content

It is clearly observed in fig. 4.4 that a mix 1:6 has comparatively higher water content than the other two mix. It is due to higher sand proportion in the sample considering the increased porosity of the higher-sand mix, allowing more water to be absorbed compared to the lower-sand mix.

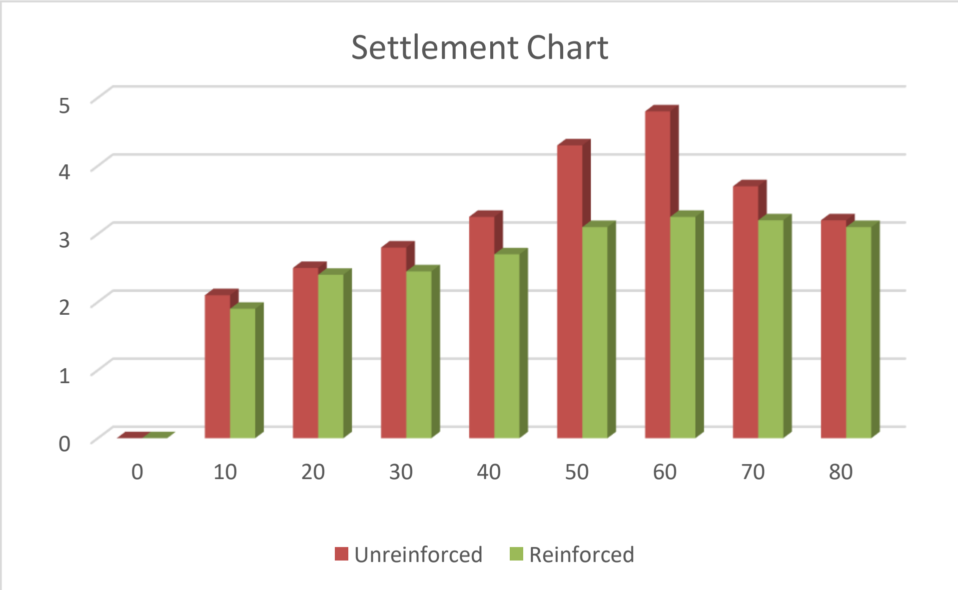

Fig. 4.5: Load v/s Settlement Chart

Fig. 4.5 shows that the soil sample reinforced with geo-jute has less settlement compared to its unreinforced counterpart. The settlement in the unreinforced soil sample increases with the added load and starts to drop around 60 kg; whereas there is gradual and consistent increasing settlement in reinforced sample with added load. The layers of reinforcement in the soil sample distributes the stress compared to unreinforced sample.

Conclusion

When the load is applied on the reinforced sample, the geo-jute distributes the load uniformly on a wider area. This helps in reducing the settlement which maintains the integrity of the structure ensuring long term durability. It can be used in road construction between the sub-grade and sub-base as both the layers have major particle size difference resulting in undulation on the surface if both the layers mix into each other. It can also be used in maintenance and repairing roads. In shallow foundations, it can be used in multiple layers at a certain interval in substructure soil. It is also observed that it absorbs water, which helps in managing lateral drainage caused due to rainfall or capillary action in high water-table area preventing erosion. Hence, the objectives for the research have been achieved.

Future Scope

The potential for future research in soil addition with sand, cement and geotextile materials is extensive. His research on advanced materials such as nanomaterials and polymers, includes optimizing hybrid designs for better performance and efficiency and evaluating long-term stability in various conditions. Innovative processes, environmental impact assessment and integration with digital technologies are also important. Expanding the use of sustainable development and promoting the transfer of knowledge through cooperation and training programs will lead to further progress by providing solutions for good work and good business.

References

1. Resham and Vaishali Gupta (2019), Improvement in bearing capacity of soil, International Journal of Latest Research in Science and Technology, Volume: 08, Issue 06.
2. M.S. Dixit and K.A. Patil (2010), Effect of different parameters on bearing capacity of the soil, International Journal of Earth Sciences and Engineering, Volume 05, Issue 02.
3. Michael T. Adams and James G. Collins (1997), Large model spread footing test on geo-synthetic reinforced soil foundations, Journal of Geotechnical and Geo-environmental Engineering, Volume 123, Issue 01.
4. Chakrabarty S, Bhandari G, and Adak N (1997), Performance of model footing on compacted PFA, jute reinforcement overlaying soft clay, Volume 10, Issue 01.
5. Binquet J. and Lee KL (1975), Bearing capacity tests on reinforced earth slabs, Journal of Geotechnical and Geo-environmental Engineering, Volume: 101, Issue Number: GT12.