

# Soil Stabilization using cheap alternatives

Ankit Dahal, M.Tech in Geotechnical Engineering, Lovely Professional University

**Keywords:** Soil stabilization, Lime, Fly ash, Tire shreds, Marble dust, Plastic, Cement, Methodology review etc

## ABSTRACT

Appropriate bearing strength of soil is the most important requirement for design of structures on soil. Soil doesn't always have sufficient stability depending upon the soil conditions and upcoming many ground improvement techniques have been adopted in different parts of the globe to enhance the bearing capacities and stability under existing conditions. This paper reviews different methodologies adopted for improving the stability of soil of different soils based on various research papers which includes making the use of cheap alternatives such as lime, fly ash, scrap tires, sisal fibers, cement etc with various experimental, analytical and numerical method and case studies conducted on different soil types having different soil parameters and engineering properties.

## INTRODUCTION

In geotechnical engineering, **Soil stabilization** is a general term for any physical, chemical, mechanical, biological or combined method of changing a natural soil to meet an engineering purpose. The enhancement of the soil properties includes increasing the bearing capabilities, strength (tensile and shear), and overall performance of soils, sands, and waste materials in order to stabilize the soil.

Selecting methods of improving capacity of soils is necessary in many cases for the construction of foundation. Soil investigation is carried out to establish existing ground conditions and soil properties for selection of suitable foundation types for the structure.

When, the soil is found to be poor condition of bearing strength and poor stability or filled subsoil, some modifications have to be made by the engineer making the use of available options. This paper discusses different methods of improving the soil quality and stabilizing the present condition of soil in a cheaper and alternative way based upon different research papers.

Different methods used to stabilize soil in shown in the following illustration out of which the cheaper, faster and the most convenient methods are briefed reviewing various studies. Physical, mechanical and chemical are the main methods for stabilizing soil which comprises of various other techniques.

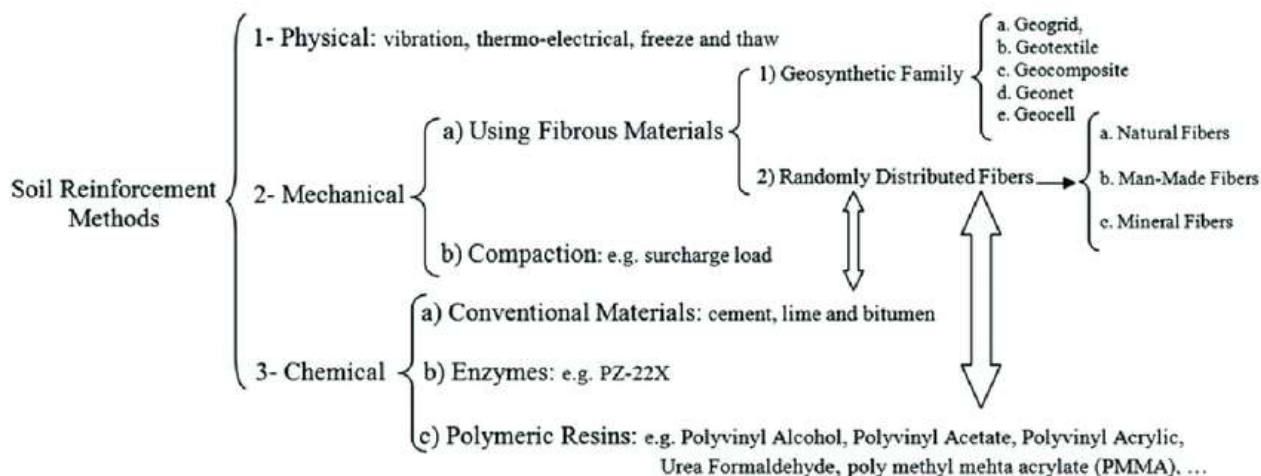


Figure: Soil Reinforcement/Stabilization Techniques. (Hejazi et al., 2012)

### *Lime Treatment:*

In order to change the properties of soil or to improve, lime is used as an additive either in form of powder form or liquid. Lime treatment shows significant increase in the workability and plasticity as well as the shrinkage limit. Precautions and calculative mixing methods should be taken into consideration while treating weak soil with lime with respect to the properties and amount of soil. **Lime** is a calcium-containing inorganic mineral composed primarily of oxides, and hydroxide, usually calcium oxide and/ or calcium hydroxide which doesn't have any smell and is white in color.



Figure: Lime treatment on soil (Source: Google)

### *Tire Shreds:*

These waste materials act as fibrous material to keep soil masses attached to each other. Cutting waste tires into different sizes as per the requirement of amount of soil to be stabilized and mixing it followed with mechanical compaction shows significant increase in the bearing capacity, shear stress which results in the improvement of soil property. This can have a huge essence in the area of slope stabilization as it makes the uses of waste material and is cheaper. Different sizes of these waste tire scraps are used (usually in rectangular shapes) with different amount in order to check the optimum stability and strength in the reinforced soil for enhanced soil properties with better work abilities.



Figure: Tire shreds and soil Mix

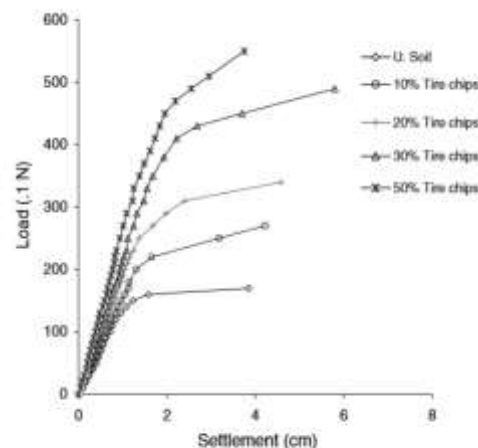


Fig. 4. Load-settlement curves for 2 x 8 cm shreds with different shred contents.

(Source: N. Hataf, M.M. Rahimi)

### *Fly Ash*

Fly ash or flue ash, also known as pulverized fuel ash, is a byproduct of combustion of coal that consists of the particulates (fine particles of burned ammunition) that are propelled out of coal fired boilers together with the fuel

gases. Ash that settles down towards the bottom of the furnace chamber is known bottom ash. It is used as an additive for soil stabilization as it acts as a binding material for soil masses because of its cementations property. It is classified as F class and C class as per its properties and method of production. Along with its use in making cement the can also be used as substitute aggregates, grout-fill, embankments, road sub-base etc which as a whole is the process as of soil stabilization. They are also good additives which helps in improvement of soil cohesion due to their binding property and cementing nature.



Figure: Fly ash



Figure: Fly ash Treatment of soil (fhwa.dot.gov)

#### *Marble Dust*

The powder like byproduct accumulated while making, shaping or modifying marbles is basically called marble dust. They are formed in both slurry and powder form. Mixing these with weak soil masses with different percentage by weight of soil shows significant increase in the workability of soil with improved soil properties. Marble dust is mostly used to alter the maximum dry density of the material and to treat soil with swelling anomaly. Treating soil with fly ash requires curing time from 7 to 28 days to show strength.

#### *Cement:*

Compared to above alternatives, cement treatment for soil stabilization is a bit expensive although is cheaper and more convenient when we compare the results. The volume of cement to be applied to the weak soil depends upon the properties of soil and their required modification as per the desired strength and purpose of work. Like fly ash, the mixture also requires certain period of time to gain its strength which is followed by mechanical compaction.

#### *Sisal Fiber*

This can be considered as one of the cheapest and effective way of soil reinforcement technique as it makes the use of natural resources. The fibers act as a thread to bind the soil particles together in the form of a coherent matrix which results in the increased strength and stability of soil masses. They can be best used in slopes for stability to minimize erosion of soil. They have different effect on soil with their different % of mixture. The length of these fibers also affects the soil properties thus test should be carried out to find the optimum content and length that gives soil maximum stability and strength.



Figure: Sisal Fiber (Source: Google)



## LITERATURE REVIEW

Ankit Singh Negi, Mohammad Faizan, Rehan Jot Singh (2013) reported; Lime is a magnificent additive used to stabilizing soil which goes under persistent change in volume. It shows immediate reaction and upgrades various soil properties such as CBR value, compression, bearing capacity along with the decreased plasticity index.

N. Hataf, M.M. Rahimi (2005) reported; Using tired scraps and shreds as reinforcing agent results in the increase in bearing capacity from 17% to 83% when 10% of tired scraps by weight of soil were used. Similarly, the bearing strength increases till 40% addition of tire shreds beyond which no significant increase in observed.

Dr. Robert M. Brooks (2009) reported; the use of fly ash along with some percentage of rice husk resulted in decrease in the swelling property of soil with increase in CBR value. The stress strain behavior of the UCS results increase in failure strain and stress till 25% addition of fly ash by weight of soil.

Riddhi Choksi, C.B. Mishra, Nandan Patel (2018) reported; The addition of marble dust in increasing rate results in increased maximum dry density with decrease in the moisture content. The CBR value and UCS also showed increment of 2.76 times and 1.5 times respectively as compared to natural soil.

J. Prabhakar, R.S. Shridhar (2002) reported; The introduction of sisal fiber as reinforcing agents resulted decrease in dry density of soil mass. Initially the OMC was observed to increase but further increasing the amount of sisal fiber reduced the OMC. There is increase in the shear stress till 20mm length of a fiber beyond which it fails to interlock the soil particles. The cohesion of the soil increases with the introduction of sisal fibers up to 0.75% increment by weight of soil.

## CONCLUSION

This study presents a methodological review of various ways to improve the soil quality and bearing capacity along with their experimental works. The research papers reviewed and compared above presents different cases around the world along with the materials used. There are many methods mentioned above to improve the bearing capacity of soil like making the use of bamboo, fly ash, geo-synthetics, lime, cement, tire shreds of different sizes, different natural fibers, stone columns, micro-piles etc.

The information present in the paper is collected from practical, theoretical as well as analytical method for experiments and case studies that will help identify the undergoing or upcoming geotechnical problems related to improvement of bearing capacity of soil.

## REFERENCES

- 1) J. Binquet and K. L. Lee, "Bearing capacity tests on reinforced earth slabs," *Journal of Geotechnical Engineering Division*, vol. 101, no. 12, pp. 1241–1255, 1975.
- 2) Brooks, R.M., 2009, "Soil stabilization with fly ash and rice husk ash", *International Journal of Research and Reviews in Applied Sciences*, 1(3): 209-217
- 3) Negi, Ankit Singh., Faizan, Mohammad, Pandey, Deashish., Singh, Rehanjot., 2013, "Soil Stabilization using lime", *International Journal of Innovative Research in Science, Engineering and Technology*.
- 4) Prabhakar, J., Sridhar, R.S., (2002), "Effect of random inclusion of Sisal Fiber on Strength Behavior of Soil", *Construction and Building materials* 16(202) 123-131
- 5) Choksi, Riddhi., Mishra, C.B., Patel, Nandan., (2018), "Pursuance of waste Marble Powder to improve soil stabilization", *International Research Journal of Engineering and Technology (IRJET)*
- 6) N. Cesar Consoli; M. Antonio Vendruscolo; and Pedro D. Marques Prietto, "Behavior of Plate Load Tests on Soil

*Layers Improved with Cement and Fiber.”*

- 7) N. Hataf \*, M.M. Rahimi,” *Experimental investigation of bearing capacity of sand reinforced with randomly distributed tire shreds.*”
- 8) White, D.J., (2005),”*Fly Ash Soil Stabilization for Non-Uniform Sub-grade Soils*”, Iowa State University. *Volume I: Engineering Properties and Construction Guidelines (IHRB Project TR-461, FHWA Project 4).*
- 9) Hejazi, S.M., M. Sheikhzadeh, S.M. Abtahi and A. Zadhoush, (2012),” *A simple review of soil reinforcement by using natural and synthetic fibers*”, *Construction and Building Materials*, 30: 100-116.
- 10) M. Aziz Özdemir,” *Improvement of Bearing Capacity of a soft soil by the addition of fly ash.*”
- 11) M. Mamatha, S. Kommu,”*Improvement of Bearing Capacity of soil using Bamboo and Geo- Synthetics.*”
- 12) A. Sengupta, S. Mukherjee, A. Ghosh,” *Improvement of Bearing Ratio of Clayey Sub-grade Using Compacted Fly-ash Layer.*”

