A Review on Soil Stabilization Comparing Traditional and Non-Traditional Additives

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ABSTRACT:

The Infrastructure is a major part that enhances overall development of the Indian financial system. Fast emergent population needs new roads bigger cities and industrialization to produce source of revenue, stabilization of soil becomes necessary as it improves soil properties to withstand the loads from infrastructure. This is a review paper on soil stabilization focusing on comparison between traditional and non-traditional additive used in soil stabilization. Use of non-traditional additive such as tire, jute, fibres etc. not only improves soil properties but also solves the problem of waste clearance.

Keywords- CBR, infrastructure, MDD, OMC,RHA,stabilization,and UCS

I. INTRODUCTION

Probing for the best soil stabilizers to conquer problems occur by the soft soils are still being the major concern, not only to achieve the required soil engineering properties but also by taking into consideration the cost and the effect to the environment. The purpose of this paper was to review the techniques and compare them for soil stabilization based on experimental studies. Investigation on various materials had been studied in order to estimate their effectiveness as soil stabilizer, which involved the use of additive, fly ash geopolymeric binder, various ashes and cementitiousbinders. Thesematerials were discussed in this paper and their effectiveness for stabilizing soft soils were observed from the studied results,only in term of strength, basedon unconfined compressive strength (UCS) test and California Bearing Ratio (CBR) test that had been conducted.

Researchers are motivated to create new technologies and methods to improve the techniques that are being used to utilize the resources for the sustainability of the materials in the long run. Thus it becomes necessary to make use of such techniques to make the best use of resources. Civil engineering aspect of proper utilization includes land stabilization through which we can modify land with inferior engineering properties into land which has adequate engineering properties. Stabilization in extensive sense incorporates the various methods in use for modifying the properties of a soil to improve its engineering performance, which can be done by various methods. Soil stabilization can be classified under two main categories, mechanical and chemical stabilization.

Mechanical stabilization include soil remolding, grade enhancement and compaction while chemical stabilization includes mixing of admixtures to improve soil properties, these admixtures can be categorized as traditional admixtures and non-traditional admixtures.

1.1 Mechanical Stabilization

Under this class, soil stabilization can be achieved through substantial process by varying the physical nature of native soil particles by either induced vibration or compaction or by applying other physical properties such as barriers and nailing.

1.2 Chemical Stabilization

Under this class, soil stabilization depends mainly on chemical reactions between stabilizer (cementitious material) and soil minerals (pozzolanic materials) to achieve the desired effect. The choice to technical usage depends on which soil properties have to be modified. The main properties of soil which are of interest to engineers are volume stability, strength, compressibility, permeability and durability.

1.3 Various Methods of Stabilization

- In-situ Stabilization
- Deep mixing methods
- Wet mixing
- Dry mixing
- Electrical Stabilization of Clayey Soil
- Soil Stabilization by Geotextiles & Fabrics

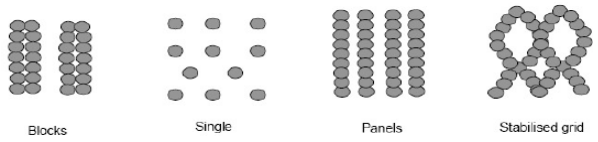

Fig. 1: Typical patterns of deep soil mixing

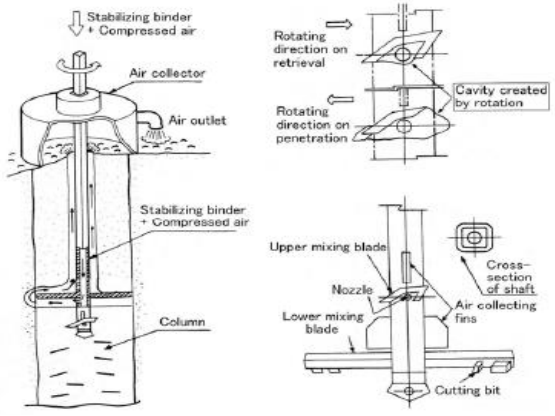

Fig. 2: Schematic diagram of construction principle and structure of mixing blade

1.4 Factors Affecting the Stabilized Soil

Occurrence of organic matters, sulphates, sulphides and carbon dioxide in the stabilized soils may contribute to undesirable strength of stabilized materials.

II. LITERATURE REVIEW

The relevant researches in the field of soil stabilization are showcase in the table below:

S .No.	Authors	Year	Subject	Results
1	Donald H. Gray et al,	1983	Mechanics of Fiber Reinforcement in Sand	Experimental behavior was compared with theoretical predictions based on a force equilibrium model of a fiber reinforced sand. Test results showed that fiber reinforcement increased the peak shear strength and limited post peak reductions in shear resistance. The fiber reinforcement model correctly predicted the influence of various sand-fiber parameters through shear strength increases that were: (1) Directly proportional to concentration or area ratio of fibers; (2) greatest for initial fiber orientations of 60° with respect to the shear surface; and (3) approximately the same for a reinforced sand tested in a loose and dense state, respectively. **(4)**
2	M.D.AnisurRahman	1986	The potentials of some stabilizers for the use of lateritic soil in construction	The potentials of rice husk ash compared to lime and cement in lateritic soil stabilization. For road construction, it recommends 7% cement for base materials, 5% lime for sub-base materials and 18% rice husk ash for sub-base materials.**(5)**
3	Sivapulliaiah et al.	1996	Effect of fly ash on the index properties of black cotton soil.	The influence of fly ash is related to particle size distribution , free lime content and pozzolanic reactivity of it. The effect of the coarseness of fly ash particles is to decrease the activity and plastcity index of the soil.**(6)**
4	Misra et al.	2005	Physico-mechanical behavior of selfcementing class C fly ash–clay mixtures	The clay-fly ash samples rapidly gained compressive strength and stiffness within curing period. By increasing in fly ash content, swelling potential of stabilized clay ma reduces and CBR values improves. **(3)**
5	Amin EsmaeilRamaji	2012	A Review on the Soil Stabilization Using Low-Cost Methods	A lot of waste rubber are generated and occupied a great space. It is necessary to find a solution to solve this problem. Based on literature, one of the solutions is use of different size waste rubber in soil reinforcement. Based on literature, Portland cement, lime,

				fly ash and scrap tire are low-cost and effective to soil stabilization.**(2)**
6	S.Z. SharifahZaliha et al.,	2013	Review on Soil Stabilization Techniques	The techniques that had been done for soil stabilization based on experimental studies. Investigation on various materials had been done in order to evaluate their effectiveness as soil stabilizer, which involved the use of sodium hydroxide additive, fly ash geopolymeric binder, various ashes and cementitiousbinders. **(8)**
7	Omar S. Baghabra Al-Amoudi et al.	2017	Method and Mechanisms of Soil Stabilization Using Electric Arc Furnace Dust	The findings of this study indicate that marl and sand stabilized with cement and EAFD can be used for the sub-base of rigid and flexible highway embankments. The stabilized soils have proven to be durable and leaching of heavy metals in these mixtures is within the USEPA acceptable limits. ()
8	AbhinavRawat, AnupamMital	2015	A Review Paper On Soil Stabilization Using Different Traditional And Non-Traditional Additives	A review on soil stabilization focusing on different type of traditional and non-traditional additive used in soil stabilization. Use of nontraditional additive such as tire, jute, fibers etc. not only improves soil properties but also solves the problem of waste disposal.(1)

III. METHODOLOGY and DISCUSSION

The literature study shows that many researchers have worked for using sustainable materials for the stabilization of soil.

Basic principles in soil stabilization may be stated as follows:

- Evaluating the properties of given soil
- Deciding the method of supplementing the lacking property by the effective and economical method of stabilization
- Designing the stabilized soil mix for desired stability values. •Considering the construction procedure by adequate compaction of stabilized layers.
- Soil stabilization may result in any one or more of the following changes:
- Increase the drain ability of the soil
- Increase stability
- Control the undesirable effects associated with clay.
- Reduce settlement

Type of Stabilization	**Process**	**Remark**
Mechanical Stabilization**(3)**	The Objective of mechanical stabilization is to blend different available soils so that when compacted, they give the desired stability. In some areas the natural soil at an existing location may have weak in nature (poor CBR). It may due to clay, silt or fine sand. Suitable soil may be selected (contains granular material) and this is to be blended with the available soils to improve the soil properties at a lesser cost in manpower and materials to achieve best results (Increase of CBR).	Limitation of mechanical stabilization: • Original soils contains fines, use of coarser fractions for blending may be expensive • If clay has been added to "Stabilize" soils, it should be susceptible to frost action. • Creation of dust clouds results in nuisance to traffic • Reduction of soil cohesion (or) binding forces ultimately leads to material disintegration.
Chemical Stabilization**(1)**	These are chemical substances that can enter in the natural reactions of the soil and control the moisture getting to the clay particles, therefore converting the clay fraction to permanent cement that holds the mass of aggregate together. The chemical stabilizer in order to perform well must provide strong and soluble cations that can exchange with the weaker clay cations to remove the water from the clay.	Limitationof chemical stabilization: • In the case of cement stabilization increase in cement content causes increase in strength and durability [Higher cost]. The presence of Magnesium sulphate reacts with hydrated cement and cause reduction in strength. • In the case of lime stabilization, it creates a dust (Hydrated lime) and this is not suitable for thickly populated areas. Water is a critical component in compaction. Less water results in adequate compaction and more water makes compaction ineffective.
Bio-enzymatic Soil Stabilization**(5)**	Bio-enzyme is a natural, non-toxic, non-flammable, non-corrosive liquid enzyme formulation fermented from	In clay water mixture positively charged ions (cat-ions) are present around the clay particles, creating a film of water around the clay particle that remains attached or

	vegetable extracts that improves the engineering qualities of soil, facilitates higher soil compaction densities, and increases stability. Enzymes catalyze the reactions between the clay and the organic cat-ions and accelerate the cat-*i*onic exchange process to reduce adsorbed layer thickness.	adsorbed on the clay 14 surface. The adsorbed water or double layer gives clay particles their plasticity. In some cases the clay can swell and the size of double layer increases, but it can be reduced by drying.
Soil Stabilization by Geotextiles**(4)**	The geotextile and geofilm imparted significantly higher cohesion strength than the geogrid product. Geofilms should not be considered an appropriate erosion control material for soil stabilization at contaminated-soil sites.	A study performed to assess the load-bearing capabilities of sand reinforced with geosynthetics yielded results that also indicate geosynthetics will reduce soil erosion and can help prevent slope failures

IV. CONCLUSION

Annually, a lot of waste materials like rubber, fly ash, steel slag, organic and inorganic fibres, blast furnace slag, bio enzymes, lime – cement and many industry remnant ashes are generated and occupy a great space.

It is necessary to find a solution to solve this problem:

- Based on literature, one can arrive to an option of Mechanical Stabilization.
- Mechanical Stabilization does not increase the self-weight of the materials.
- Based on literature, Portland cement, lime, fly ash and scrap tire are low-cost and effective to soil stabilization.

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