A Review on Stabilization of Expansive Soil with various admixtures

Dr.K.Murali[*], S.Ashok[**], N.Giridharan[**], K. Kaniyan pandiarasan[**], P.Logesh[**]

[*] Professor in Civil Engineering, Sri Ramakrishna Institute of Technology, Coimbatore
[**] UG Student, Department of Civil Engineering, Sri Ramakrishna Institute of Technology, Coimbatore

DOI: 10.29322/IJSRP.8.4.2018.p7629
http://dx.doi.org/10.29322/IJSRP.8.4.2018.p7629

Abstract- Expansive soil or clayey soil which can change its volume when the water content is available i.e., swelling and shrinkage occurs. In urban areas, borrow earth is not easily available which has to be hauled from a long distance. Quite often, large areas are covered with highly plastic and expansive soil, which is not suitable for such purpose. It results on damage of building structures and road pavements due to its low strength and high expansion. The usage of admixtures can adversely improve the soil properties, thus stabilizing the clayey soil. A critical review on various admixtures used for stabilization of expansive soil is discussed in this paper.

Index Terms- Expansive soil, Fly Ash, Bagasse Ash, Coir waste, Lime

I. INTRODUCTION

An expansive soil is any soil that is prone to large volume changes i.e., shrinkage and swelling which related to changing moisture conditions. Cyclical water ingress and removal causes moisture imbalance that triggers the “Shrink-Swell Cycle” [1]. This affects the foundation layer, runways, railways, roads. So, the soil property has to be improved through mechanical stabilization i.e., compaction. If not, the chemical admixture technique is used to achieve the desired strength. The addition of waste product can improve the strength properties of clayey soil. The expansive soil has two kinds of minerals i.e., original minerals and clay minerals. Original minerals (Quartz, Feldspar, Mica) are not considered due to their low amount and activity. Clay minerals (Montmorillonite, Illite, Kaolinite) are greatly influence the engineering properties of expansive soil. To reduce these minerals, different kind of admixtures such as bagasse ash, fly ash, coir waste, egg shell powder, quarry waste etc., can be used. These admixtures has the tendency to improve the engineering properties of soil.

Stabilization is the alteration of foundation soils to conform to desired characteristics or the improvement of a less stable soil in both strength and durability [2]. Stabilization can increase the shear strength of a soil and control the shrink-swell property of a soil, thus improving the load bearing capacity of a subgrade to support pavements and foundations. The main objective of this paper is to critically review the admixtures for stabilization of expansive soil.

II. REVIEW

A. Bagasse Ash

Bagasse ash is a fine residue collected from burning of bagasse fibers after crushing for sugarcane juice. Bagasse ash is a non-cohesive material having a low specific gravity and it comprises of high content of silica and since it burnt, it behaves as a pozzolanic material, thus it can be used for the stabilization of road subgrade [3], [4], [5].

Hydrated lime which has 85-95 % of calcium hydroxide [3] is an inorganic compound. The various tests are to be conducted with bagasse ash alone which in turns slightly it improves the strength of the clayey soil. The increase in strength of the combined hydrated lime-bagasse ash is higher than that of bagasse fibres employed alone [4], [5].

On the investigation with [3], calcium carbide residue is used as a admixture blended with bagasse ash to improve the strength of the clayey soil. CCR contains high CaO, so that it considered to be an admixture to reduce the plasticity index, expansion potential as well as to increase the shear strength and compressive strength of soil. The addition of bagasse ash to CCR significantly improves MDD, especially on 28 days curing time.

B. Coir Waste

Coir waste consist of coir pith and coir fibre is a by-product of coir manufacturing industry obtained from coconut husk during the extraction of coir fibre [6]. The various proportions are made for coir pith and coir fibre mixed with soil.

When the addition of coir pith alone to the soil in presence of water, it will absorbs the water and fill the voids of soil thus contributing to the dry density. At higher coir pith content, the optimum moisture content increases. The coir fibre shows the similar result as that of coir pith. When both coir pith and coir fibre are used at a correct proportions with the soil, the maximum can be attained.

The CBR value attained for both soaked and unsoaked conditions increases with the increase in fiber content. Thus the significant increase in CBR value of soil due to the addition of coir fiber will substantially reduce the thickness of pavement subgrade [7]. From the review, it was found that the preparation of identical soil samples for CBR test beyond 1% of fiber content was not possible and optimum fiber content is found to be 1 % by dry unit weight of soil.

The soil reinforcement is also a method to improve the bearing capacity and to reduces the settlement [8]. The square footing was prepared as a model by providing reinforced layer with various proportions of coir fiber. Therefore, the provision of coir reinforced layer increases bearing capacity and reduces settlement, which found to be economical techniques among various types of bearing capacity improvement techniques.

C. Egg Shell Powder and Quarry Dust

Egg shell powder has the similar chemical composition as that of lime, this can be used as the stabilizing material instead of using lime. From the domestic sources such as poultries, hatcheries and food centers are collected [2]. With the addition of ESP alone constantly, there is an increase in OMC and decrease in MDD. With varying percentage of ESP, shear strength increases, permeability increases. With the addition of optimum percentage of ESP and varying percentage of quarry dust, further increases the MDD and decreases the OMC and the shear strength, angle of internal friction increases and the cohesion decreases.

So, that the ESP alone with quarry dust used in combination with clayey soil possessed certain properties can be used for the improvement of clayey soil. From [9], the various tests are to be conducted to determine the optimum quantity of lime and the optimum percentage of lime ESP combinations. Here, the optimum quantity of lime is gradually replaced with amount of eggshell powder. It was found that, the lime stabilization is better than the combination of ESP and lime.

D. Fly Ash

The annual production of fly ash in India is about 184 million tons per year and also it increases day by day. Fly ash can be obtained from the combustion of sub-bituminous coal exhibit self-cementing characteristics. Fly ash treatment can effectively reduce the swell potential of highly plastic clay and thus prevents the swell beneath the small foundation pressure. For highly expansive clay, a combination of fly ash with small percentage of lime is recommended for stabilization [10].

The plasticity index of fly ash treated soils decreases mainly due to an increase in plastic limit. Liquid limit may increase or decrease depending upon the type of soil. The greatest problem occur in soils with a high montmorillonite content. Different clays have different susceptibility to swelling [11]. Fly ash itself has little cementitious value but in the presence of moisture it reacts chemically and improve the strength and compressibility of soils [12].

When the fly ash is added to the clayey soil, the California bearing ratio and unconfined compressive strength of the soil will be increased and thus improving geotechnical properties. Stabilization of weak soil with fly ash not only improves engineering properties of soil but also provides answers to issues of fly ash disposal [13].

D. Lime

Stabilizing expansive soil by adding lime is an ancient art and an age old practice, which has been followed all over the world. When lime is added to clayey soils provides an abundance of calcium magnesium ions, also sodium and potassium present on clay mineral plates. Lime stabilization has proved to be one of the most efficient techniques used to mitigate swell potential [14].

The chemical reaction occurring between lime and soil is quite complex. The stabilization apparently occurs as a result of two processes. In one process, the base-exchange occurs with the strong calcium ions of lime replacing weaker ions such as sodium. In other process, a change of soil texture flocculation of the clay particles takes place when lime is mixed with clays [15]. Due to the cationic exchanges, the lime can significantly reduce the swell potential. As lime content increases, there is significant improvement of silt fraction and reduction in clay fraction, free swell and swell pressure. The usage of lime alone can slightly increase the strength but not much more than the admixtures which are added to the lime and soil mix[4]. The combination can adversely increase the stability of the soil than lime employed alone.

III. CONCLUSION

The clayey soil is a serious problem in construction which can be seen all over the world causes damages to the structures. The purpose of this study was to investigate the usage of admixtures in stabilizing the expansive soil. The following conclusion are studied from the review,

i. The strength increases when the addition of bagasse ash and lime with suitable proportions than treated with bagasse ash alone.
ii. Bagasse ash when mixed with CCR shear strength and compressive strength of expansive soil increases significantly.
iii. The engineering properties of soil can be stabilized by the usage of coir waste and the combined treatment i.e., coir pith and coir fiber increased the CBR value by 4.6 times.
iv. The shear strength, MDD, angle of internal friction increases and the OMC, cohesion decreases with the optimum percentage of ESP and increase in quarry dust.
v. The characteristics and strength of a highly expansive soil can be improved by fly ash stabilization.
vi. The fly ash treatment is effective in improving the plasticity index of the soil. Since there is much more fly ash that is disposed off rather than utilized making more productive use of fly ash would have considerable environmental benefits.
vii. Due to cationic exchange in lime stabilization, which lead to agglomeration and flocculation of soil, it causes significant effect in many properties of expansive soil such as plasticity index, compaction, swell potential, reduction of clay fraction and increase of silt and sand fraction.

REFERENCES

[1] Emilio M. morales, MSCE, Mark K. Morales, MSc, expansive soils – identification, detection and remediation strategies.
[2] Geethu Saji, Nimisha Mathew, Improvement of clayey soil by using egg shell powder and quarry dust, IOSR-JMCE, 46-54.
[3] John Tri Hatmoko, Hendra Suryadharma (2017), Shear behavior of calcium carbide residue – bagasse ash stabilized expansive soil, SCESCM 2016, 476-483.
[4] Liet Chi Dang, Behzad Fatahi, and Hadi Khabbaz (2016), Behavior of expansive soils stabilized with hydrated lime and bagasse fibers, ICTG 2016, 658-665.
[5] Hayder Hasan, Liet Dang, Hadi Khabbaz, Behzad Fatahi, and Sergei Terzaghi (2016), Remediation of expansive soils using agricultural waste bagasse ash, ICTG 2016, 1368-1375.
[6] Leema Peter, P K Jayasree, K Balan, Alaka Raj S, (2016), Laboratory investigation in the improvement of subgrade characteristics of expansive soil stabilized with coir waste, TPMDC 2014, 558-566.
[7] H.P. Singh, Effects of coir fiber on CBR value of Itnagar soil, IJES 2277-4106.
[8] Parag M. Chaple, A I. Dhatrak, Performance of coir fiber reinforced clayey soil, IJES Volume 2 Issue 4.
[9] O.O. Amu, A.B. Fabobi and B.O. Oke, Effect of egg shell powder on the stabilizing potential of lime on an expansive clay soil, JAS 2005, 5 (8): 1474-1478.
[10] Magdi M.E Zumrawi, Improving the characteristics of expansive subgrade soils using lime and fly ash, IJSR 2014.
[11] Zalihe Nalbantoglu (2004), Effectiveness of class C fly ash as an expansive soil stabilizer, construction and building materials 2004, 377-381.
[12] S. Bhuvaneswari, R.G. Robinson, S.R. Gandhi, Stabilization of expansive soil using flyash.
[13] Udhayashankar D. Harari, S.C. Puranik, Stabilization of black cotton soils using fly ash, hubballidharwad municipal corporation area, Karnataka, India, GJRE volume 12 issue 2 2012.
[14] Rafaella Leite et.al., Lime stabilization of expansive soil from Sergipe – brazil, UNSAT 2016.
[15] Ishraq Khudhair Abass, Lime stabilization of expansive soil, JED ISSN 1813-7822.
[16] Lakshmi Keshav, Mangaiarkarasi.V, Effect of fly ash on an expansive soil for flexible pavement design, IJEIT 2012, volume 2, issue 3.
[17] Prakash somani et.al., Use of fly ash in black cotton soil for stabilization, SSRG 2016, volume 3 issue 5.
[18] Arash Barazesh et.al., Laboratory Investigation of the effect of Eggshell powder on Plasticity Index in Clay and Expansive soils, EJEB 2012, 2 (6):2378-2384.

AUTHORS

First Author – Dr.K.Murali, Professor in Civil Engineering, Sri Ramakrishna Institute of Technology, Coimbatore, murali.vlb@gmail.com
Second Author – S.Ashok, BE - Civil Engineering, Sri Ramakrishna Institute of Technology, Coimbatore, ashok.civilak05@gmail.com
Third Author – N.Giridharan, BE - Civil Engineering, Sri Ramakrishna Institute of Technology, Coimbatore, girinc96@gmail.com
Fourth Author – K.Kaniyan pandiarasan, BE - Civil Engineering, Sri Ramakrishna Institute of Technology, Coimbatore, kanikaniyan96@gmail.com
Fifth Author – P.Logesh, BE - Civil Engineering, Sri Ramakrishna Institute of Technology, Coimbatore, logalogesh130294@gmail.com