International Journal of Constructive Research in Civil Engineering (IJCRCE)
Volume 1, Issue 1, June 2015, PP 19-23
www.arcjournals.org

Stabilization of Lithomargic Soil Using Alkali Activated Fly-Ash with GGBS

Anil Kumar[1], Shriram Marathe[2,] Vikram R[3], Nagraj Shenoy[4], Vaishnavi L Bhat[5], Venkatesh A[6]

[1,2]Assistant Professor Department of Civil engineering, NMAMIT, Nitte, Karnataka, India
[3,4,5]UG student Department of Civil engineering , NMAMIT, Nitte, Karnataka, India
anil_nitk@yahoo.com

Abstract: *Stabilization is one of the most common methods for treating the expansive soils to make it suitable as an engineering material. Disposal of a massive amount of industrial wastes as fill material on disposal sites nearer to industries not only needs a large space but also induce a huge geo environment problem. The production of alkali activator by utilizing industrial waste materials has become an important field of research as it is possible to use these materials to produce a non expensive and ecologically sound cement like stabilizing material. The activation of waste materials such as fly ash in an alkaline medium is a chemical process that allows the user to transform glassy structures (partially or totally amorphous and/or metastable) into a very compact cemented stabilization material. Present study is focused on the new and eco-friendly method adopted in soil modification. Studies were carried with polymerization of Lithomargic soil using industrial waste by products such as fly ash and GGBS. Evaluation of un-confined compressive strength (UCS) and California Bearing Ratio (CBR) of lithomargic soil treated with various dosages of such alkali activated polymers for a time period of 0, 7, 14 and 28 days at different dosages of alkali activated fly-ash and GGBS. The outcome from the laboratory investigation revealed that using alkali activated geo-polymer the soil can be effectively stabilized and can be used in improving the engineering properties of weak lithomargic soil.*

Keywords: *Lithomargic soil, Fly-ash, GGBS, NaOH flakes, Stabilization, G-eo-polymer.*

1. INTRODUCTION

The large scale infrastructural and industrial development in our nation has resulted in reduction of construction materials and an adverse effect on the hygienic environment. Nowadays, poor properties of soils are a critical issue in engineering projects related with foundation material. The ideal soil should have adequate strength, relatively incompressible and proper permeability in any of the Constructional activity. It is not necessary that soil should satisfy all these needs. Thus there is need to improve the soil properties. When there is need to improve the poor soil at construction site, the best technique used is soil stabilization.

Improvement of soil with ready available materials have shown overall increase in the budget of the project leading to a need to investigate the feasibility of industrial wastes to replace the conventional building materials. Modification of the in-situ soil having inadequate engineering properties are necessary to utilize the soil as foundation or sub grade material and thereby making the in-situ soil suitable for engineering application.

The present study is been carried out to stabilize the week soil (Lithomargic soil) using alkali activated geo-polymers using the waste industrial products as GGBS and fly-ash with a molarity of 14 at different proportion(0,10,15,20,25,30 percentages) at different curing period of 0, 1, 3 and 4weeks. Tests were conducted related to compression strength.

2. LITERATURE REVIEW

Number of studies has been conducted by various researchers on the use of industrial waste materials in modifying the engineering properties of weak soil.

Oormila.T.R et al., (2014) the work was carried out in stabilization of the soil using grounded blast furnace slag (GGBS) and fly-ash. They conducted test using unconfined compressive strength (UCS) test and California Bearing Ratio (CBR) test with different dosages of GGBS (15%, 20%, and 25%) and fly-ash (5, 10%, 15%, and 20%) respectively. They found that maximum CBR value was achieved by blending 20% GGBS.

Tejas Ostwal et al., (2014) In this research they considered to develop geo-polymer blocks to replace cement concrete blocks The geopolymer blocks was prepared without using cement. The considered materials such as Class F Fly ash, finely grounded blast furnace slag (GGBS), stone crusher and sand. The NaOH (Sodium hydroxide) and Na_2SiO_3 (sodium silicate) were used as agents for alkaline activation. They also found that geo-polymer concrete block had developed strength at ambient curing conditions.

Babu et al., (2013) carried a study on stabilization of Soft marine clays in the improvement of its strength characteristics; hence they stabilized the clay by treating it with different percentage of geo-polymer. They studied the strength characteristic of clay by blending geopolymer with clay and proved that geopolymer stabilization was effective.

Gyanen et al., (2013) this paper represents soil stabilization using fine and coarse fly ash as blending material. They studied with various dosages of fine and coarse fly ash mixtures which was used for modifying weak black cotton soil ranging from 5% to 30%. In the laboratory investigation, they found that with varying dosage of fine and coarse fly ash improves the engineering properties of expansive black cotton soil and exhibit relatively well defined peak in proctor compaction curve. Thus from these studies in can be concluded that industrial wastes can be used in soil stabilization.

2.1. Study Area

Fine grained lithomargic soil, which is widespread over parts of southwest coast of India. It is represented by Lithomargic soil (locally named shedi soil). This soil is a problematic one and is very sensitive to water. This soil when gets saturated, loses its shearing strength to a great extent. In the present work the soil samples were collected from NET, campus near MBA ground, Nitte, Karkala.

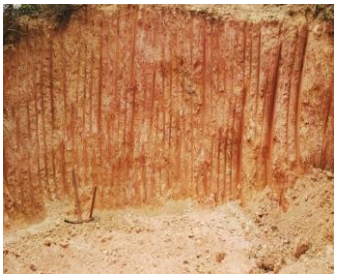

Fig1. *Site near NMAMIT. nitte*

2.2. Objectives

The major aims of the present investigation is to

- Study the basic Engineering properties of *Lithomargic* soil (Shedi Soil).
- Study the effect of GGBS in soil and to check the strength improvement of *Lithomargic soil.*
- Laboratory investigation of shear strength by conducting unconfined compressive strength (UCS) test the lithomargic soil treated with different dosages of activated fly ash-GGBS mixture on an interval of 0, 7, 14 and 28 days.

3. MATERIALS USED

The present investigation was carried out on stabilization of *Lithomargic soil* passing through 20mm sieve, by alkali activated Geo-polymers using NaOH flakes, GGBS and Fly ash.

3.1. Sodium Hydroxide Flakes

Sodium hydroxide (NaOH), also known as lye and caustic soda, is an inorganic compound. It is a white solid and highly caustic metallic base and alkali salt which is available in pellets, flakes, granules, and as prepared solutions at a number of different concentrations. In our experimental work it was brought from ‘Sai Traders’, Mangalore.

3.2. Ground Granulated Blast Furnace Slag (GGBS)

Ground-granulated blast-furnace slag (GGBS) is obtained by quenching molten iron slag from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. In our experimental work it was brought from ‘Quality Polytech’, Mangalore.

3.3. Fly Ash

Fly ash is a waste product obtained from the burning of coal. In the present work it was collected from UPCL, Thermal power plant near Udupi district.

3.4. Water

The water used for preparations of geo-polymer cement and in preparation of the moulds should be clean from all the impurities and free from all sorts of chemicals so that maximum strength can be achieved. Drinking water can also be used for mixing purposes.

4. METHODOLOGY

To assess the suitability of alkali activated geo-polymer as a ground improvement aid, tests are conducted to investigate the strength characteristics and the engineering behaviour of locally available Lithomagic soil. This lithormagic soil was procured from a NMAMIT, campus Nitte. Grain size distribution, liquid limit, plastic limit, specific gravity , compaction characteristics are determined as per IS : 2720 (part IV) 1985, IS : 2720 (part V)1985, IS : 2720 (part VI)1972 , IS : 2720 (part II /section I)1980, IS : 2720 (part VII)1980, respectively. For the present study, the soil is first tested for basic properties and then for strength parameters such as UCS and CBR with and without alkali activated geo-polymer at different proportion for a curing period from 1, 3 and 4 weeks.

4.1. Prepration of Geo-Polymer

Alkali activated fly-ash was prepared by using Sodium hydroxide solution of molarity14. Equal amount of Fly-ash and GGBS were mixed with water and NaOH solution and mixed thoroughly.

5. RESULTS AND DISCUSSION

5.1. Grain Size Analysis

Table1. *Classification of Soil Blends Based on IS 1498(1970)*

Sl. No.	Soil sample	IS Classification	Remarks/ Reasoning for classification
1	*Lithomargic soil*	MH	Silty Soil of High Plasticity PI=26.77

5.2. Determination of ATTERBERG'S Limits

The standard procedure available for LL and PL was used in the present work as per BIS (IS: 2720 (part5)-1980. Liquid limit of lithomargic soil sample was found to be 38%.

5.3. Determination of Modified Proctor Compaction Test Results

The standard test procedure as per BIS was used in the present work for IS heavy compaction test (Is: 2720 (part 8)-1983.

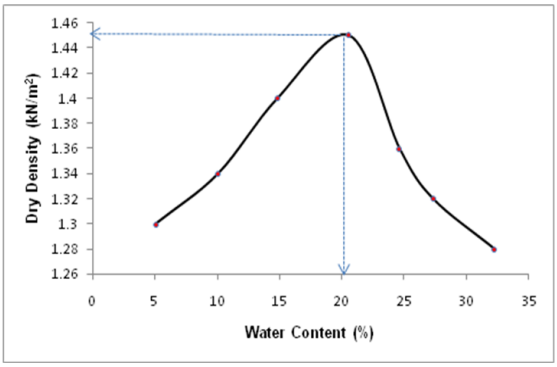

Fig3. *Compaction curve*

The dry density of given *Lithomargic Soil* was found to be 14.8kN/m^3 and 21%.

5.4. Determination of Un-confined Compressive Strength (UCS)

The Un-confined Compressive Strength (UCS) test was conducted to find the angle of internal friction and cohesion value. The UCS test is carried out as per IS: 2720 (part 10)-1973. The UCS test results for untreated soil samples are tabulated in Table: 4.4 and for alkali activated geo-polymer soil for curing period of 1, 3 and 4 weeks for heavy compaction test results shown below.

Fig4. *Prepared UCC test samples at different percentage of alkali activated geo-polymers*

6. RESULTS AND DISCUSSION

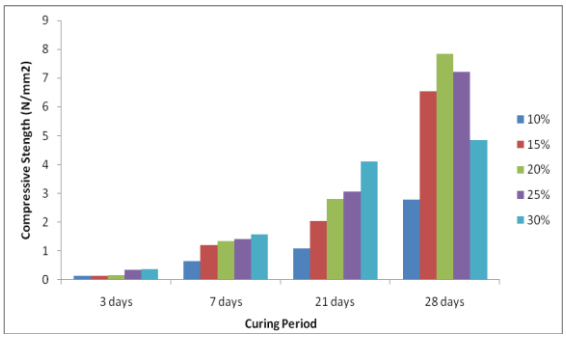

Fig4.9. *Comparison between Compressive Strength Vs Curing Period*

Table2. *Results of Unconfined Compressive Strength (N/mm^2)*

Sl. No.	Curing Time Days	Compression Strength (N/mm^2)				
		10%	15%	20%	25%	30%
1	3 days	0.137	0.148	0.157	0.359	0.374
2	7 days	0.639	1.200	1.336	1.407	1.568
3	21 days	1.091	2.034	2.803	3.052	4.117
4	28 days	2.781	6.542	7.848	7.211	4.844

From the present investigation for 14M of NaOH solution with GGBS and Fly ash it was found that 20% of alkali activated fly ash gave maximum compressive strength. Hence, this dosage can be effectively used to stabilise lithomargic soil. Results of UCS showed that the addition of alkali activated geo-polymer led to an increase in the Compressive Strength of soil samples refer table Fig.4.10 and Table 4.4

The results showed that when 10%, 15%, 20%, 25%, 30% of polymers added the Compression Strength for 7days increased to 0.639, 1.200, 1.336, 1.407, 1.568N/mm2, 21days increased to 1.091, 2.034, 2.803, 3.052, 4.117N/mm2 , and 28days increased to 2.781, 6.542, 7.848, 7.211, 4.844N/mm2 from 0 day of 0.137, 0.148, 0.157, 0.359, 0.374N/mm2 Compression Strength respectively.

7. CONCLUSION

From the present investigation for 14M of NaOH solution with GGBS and Fly ash it was found that 20% of alkali activated fly ash gave maximum compressive strength for 28 days of curing. Hence, 20% of alkali activated fly ash can be effectively used as stabilizing material**.**

REFERENCES

[1] Gyanen Takhelmayum, Savitha.A.L, Krishna Gudi (2013) *"Laboratory Study on Soil Stabilization Using Fly ash Mixtures",* International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 2, Issue 1, January 2013.

[2] Oormila.T.R & T.V.Preethi (2014) *"Effect of Stabilization Using Fly ash and GGBS in Soil Characteristics",* International Journal of Engineering Trends and Technology (IJETT) – Volume 11 Number 6 - May 2014.

[3] Dayakar Babu, K. Ramu, S. Durga Prasad, K. Ashok Kumar (2013) "*Influence Of Geopolymer on the Strength Characterstics of Sand Mixed Soft Marine Clay*", Proceedings of Indian Geotechnical Conference December 22-24, 2013, Roorkee.

[4] Tejas Ostwal, Manojkumar V Chitawadagi (2014) *"Experimental Investigations on Strength, Durability, Sustainability & Economic Characteristics Of Geo-Polymer Concrete Blocks",* IJRET: International Journal of Research in Engineering and Technology EISSN: 2319-1163 | PISSN: 2321-7308.

[5] IS: 2720 (Part II) - 1973, Determination of water content.

[6] IS: 2720 (Part IV) - 1985, Determination of grain size analysis.

[7] IS: 2720 (Part V) - 1970, Determination of consistency limits.

[8] IS: 2720 (Part VII) - 1965, Determination of moisture content dry density relation using light compaction.