International Journal of Applied Sciences, Engineering and Management
ISSN 2320 – 3439, Vol. 02, No. 03, May 2013, pp. 50 - 53

Stabilisation of Expansive Soils Using Brick Kiln Waste

Dr. B. SATYANARAYANA[1], K. PUNEETHA REDDY[2], A.S.S.SRAVANTHI[2], I.H.S.HARSHA[2]
[1] *Associate professor, Department of Civil Engineering, K L University, Guntur, AP, India*
[2] *Student, Department of Civil Engineering, K L University, Guntur, AP, India*
Email: punitha.dhoni@gmail.com, sravzz8@gmail.com, harshathethunder@gmail.com

Abstract: Soil sample collected from Revendrapadu area near Vijayawada, classified as an A-7-6 expansive soil on AASHTO classification was stabilized with 15% Brick Kiln Waste by weight of the dry soil. As per IS 2720, performance of the soil-Brick Kiln Waste was investigated with respect to compaction characteristics, and unconfined compressive strength (UCS) tests. The results obtained, indicates a general decrease in the maximum dry density (MDD) and increase in optimum moisture content (OMC) with increase in Brick Kiln Waste content. There was also an improvement in UCS with the addition of Brick Kiln Waste. The results shows increase in the strength of expansive soil by the addition of Brick Kiln Waste.

***Key Words**: Expansive soil, Brick Kiln Waste, MDD, OMC, UCS*

Introduction

Expansive clay soils are those that change significantly in volume with changes in water content. The problem with expansive soils has been recorded all over the world. In monsoon they imbibe water and swell and in summer they shrink on evaporation of water there from. Because of this alternative swelling and shrinkage lightly loaded civil engineering structure like residential buildings, pavements and canal linings are severely damaged. It is therefore, necessary to mitigate the problems posed by expansive soils and prevent cracking of structures. Many innovative foundation techniques have been devised as a solution to the problem of expansive soils. The chief among them are sand cushion technique, cohesive non-swelling (CNS) layer technique and under reamed piles. Stabilization of expansive soils with various additives has also attained lot of success. In this study, brick kiln waste is added to the expansive soil which resulted in considerable improvement in the strength characteristics of the expansive soil. Civil construction over expansive soils generally poses a major problem due to the ability to swell and shrink considerably with changes in moisture content, which consequently lead to low bearing values when wet and severe cracking when dry[1]. Expansive soils cover large area in several countries of the world and in India these soils occupies 20% of its area [2].

Expansive soils in some parts of the world are named "Black Cotton Soil". These tropical black clays range from light grey to dark grey and are black in color. The name has been given because of their black color and great suitability for growing cotton. Thus the terms tropical black clay and black cotton soil can be used inter- changeably [3]. This group is characterized by the presence of montmorillonite in the mineralogy which is capable of large volume changes from the dry to the saturated state. When wet they swell and exert high swelling pressures. These soils are poor materials to employ in construction because they contain high percentages of plastic clay. These soils are poor materials to employ in construction because they contain high percentages of plastic clay. The wetting and drying process of a sub grade layer composed of black cotton soil result into failure of pavements and structures in form of settlement[4].In areas where they occur, usually there is no suitable natural gravel or aggregates and most deposits cover significantly large areas that avoiding them is not possible. Improving the soil properties is very economical and efficient compared to borrowing a new site [5]. Soil improvement could either be by modification or stabilization or both. Soil modification is the addition of a modifier (cement, lime etc) to a soil to change its index properties, while soil stabilization is the treatment of soils to enable their strength and durability to be improved such that they become totally suitable for construction beyond their original classification [6]. There are different types of soil stabilizers. Those are cement kiln waste, fly ash, stone masonry dust (quarry dust), lime, rise husk ash. Some of these materials have rapidly increased in price due to the sharp increase in the cost of energy.

The over dependent on the utilization of industrially manufactured soil improving additives (cement, lime etc), have kept the cost of construction of stabilized road financially high. In order to make deficient soils useful and meet geotechnical engineering design requirements we should focus more on the use of potentially cost effective materials that are locally available from industrial and agricultural waste in order to improve the properties of expansive soils[7] . The use of agricultural waste (such as Rice Husk Ash) will also considerably reduce the cost of construction and as well reducing the environmental hazards they causes [8].

Brick making is a traditional but important industry in India and other developing countries. Based on the limited information available on the brick industry in India, it is estimated that more than 100,000 kilns produce about 80 to100 billion bricks per year. Brick kilns can be classified into three categories based on production capacity: small (<1million bricks/year), medium (1-2.5million bricks/year) and large (>2.5 million bricks/year). Small kilns are known as clamp kilns and are located mainly in rural areas. Medium and large kilns are of Bull's trench kiln (BTK) type and are generally located near urban and more densely populated rural areas. For burning purpose of bricks they use two different types of materials. Those are rice husk and wood. Sometimes they use any one of them and sometimes the combination of both of those materials. Brick kiln waste consists of the ash of rice husk and wood, sand, small pieces of broken bricks [13].

Rice Husk is an agricultural waste obtained from milling of rice. About 10^8 tons of rice husk is generated annually in the world. Rice Husk ash is being utilized as an admixture and for stabilization of soil which increases the cementitious property of the stabilized soil [15]. It was clearly shown that the RHA can only be used as a partial replacement for expansive stabilizing agents because it has inadequate cementitious property required to bind the material perfectly [15]. A study has been shown that both cement and rice husk ash (RHA) reduced the plasticity, maximum dry density of soils and increased optimum moisture content (OMC)[16].

Accordingly, a detailed literature review was carried out on the subject that was followed by laboratory tests. This paper describes the properties of natural clay, stabilized clay with varying percentage of brick kiln waste. The improvement of soil strength by mixing the soil with brick kiln waste and the laboratory test results have been described in this paper.

Materials Used

Expansive Soil:

The soil used in this study is expansive soil, obtained from Revendrapadu, collected at a depth of 1 m from ground level. The Index & Engineering properties of expansive soil are going to be determined as per IS code of practice and shown in Table.1.

Brick Kiln Waste:

Locally available Brick Kiln waste was used in the present work. The chemical and physical properties are determined and shown in Table.2. and Table.3.

Laboratory Studies

Following laboratory tests are carried out as per IS: 2720. The tests were carried out both on natural soil and stabilized soil with brick kiln waste collected.

1. Water Content
2. Grain Size Analysis
3. Liquid Limit Test
4. Plastic Limit Test
5. Unconfined Compression Test

Methods of Testing

Different soil laboratory tests carried out on the test sample including water content, particle size distribution, liquid limit, plastic limit and Unconfined Compressive Strength (UCS) Tests. From these test results the Geotechnical properties of the soil were determined. Test sample for UCS is prepared at Optimum Moisture Content (OMC) and Maximum Dry Density (MDD). The Brick Kiln Waste was grounded and sieved through I.S. Sieve No. 200 (75 µm) before usage.

Test Results and Discussion

The Geotechnical properties of the expansive soil before addition of stabilizers are shown in Table.1. The particle size distribution and variation of OMC and MDD with Brick Kiln Waste content shown in Fig.1 and Fig.2. The classification of the soil as per AASHTO classification system is A-7-6.

Table 1: Properties of the Natural expansive soil before stabilization

Characteristics	Description
Natural Moisture Content (%)	23.80
Percent passing I.S Sieve NO 200	77
Liquid Limit (%)	52.0
Plastic Limit (%)	25.4
Plasticity Index (%)	29.1
Group Index	20
AASHTO Classification	A-7-6
Maximum Dry Density (Mg/m3)	1.522
Optimum Moisture Content (%)	18.38
Unconfined Compressive Strength	290
Specific Gravity	2.63
Color	Black

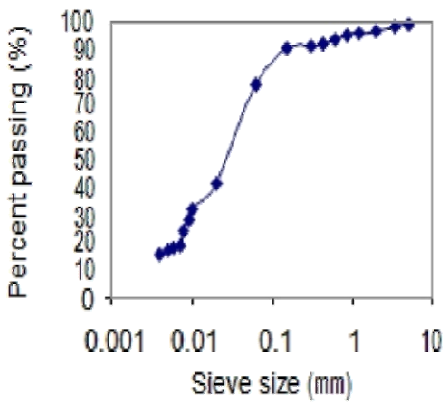

Fig.1. Particle size distribution for the natural soil

The Oxide composition of Brick Kiln Waste is shown in Table.2. The silica, Al_2O_3 and Fe_2O_3 is more than 60. This shows that, it is a good pozzolana that could help mobilize the CaOH in the soil for the formation of cementitious compounds

Table 2: Oxide composition of Brick Kiln Waste

Constitute	Composition (%)
SiO_2	82.3
Al_2O_3	4.9
Fe_2O_3	1.2
CaO	2.36
MgO	1.82
Loss On Ignition (LOI)	6.2

Table 3: Physical Properties of Brick Kiln Waste

S.No	Property	Sieve	Value
1	Grain Size Distribution	Sizes	
		4.75mm	100
		2.36mm	96
		1.18mm	80
		0.60mm	50
		0.30mm	29
		0.150mm	15
		0.075mm	8
		Pan	2
2.	Specific Gravity	2.7	

Effect of Treatment with Brick Kiln Waste

15 percentage of Brick Kiln waste was added to the test sample for testing strength of the soil.

Table 4: Influence of expansive soil and 15 percentage of Brick Kiln Waste on compaction characteristics.

Maximum Dry Density (gm/cc)	Optimum Moisture content (%)
126	33

Table 5: Influence of expansive soil and 15 percentage of Brick kiln Waste on index and compaction properties.

Liquid Limit (W_l) %	34
Plastic Limit (W_p) %	26.2
Plasticity Index (PI)	16
Specific Gravity (G)	2.69
Optimum Moisture Content (%)	20
Maximum Dry density (gm/cc)	1.25

Table 6. Influence of expansive soil and 15 percent Brick Kiln waste on Unconfined Compressive Strength (kpa).

Brick Kiln Waste %	UCS 4 days curing	UCS 7 days curing	UCS 28 days curing
15	301	470	569

Compaction Characteristics

The OMC and MDD variations with stabilizer contents are shown in Fig.2. The MDD decreased while the OMC increased with increase Brick Kiln waste content. The decrease in MDD can be attributed to the replacement of expansive soil by the Brick kiln waste. In the mixture which have relatively low specific gravity compared to that of soil. The decrease in the MDD may also be explained by considering the Brick Kiln waste as filler in the soil voids.

The results are showing that there was an increase in OMC with increase in Brick Kiln waste content. The increase was due to addition of Brick Kiln waste which decreased the quantity of free silt and clay fraction and coarser materials were formed.

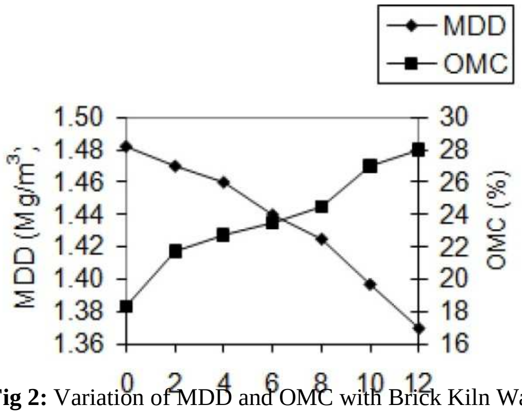

Fig 2: Variation of MDD and OMC with Brick Kiln Waste.

Unconfined Compressive Strength

From Table.6. it is observed that the Unconfined Compressive Strength increase as the curing period increases. The results shows the Unconfined Compressive Strength value of expansive soil increased from 290 kpa to 569 kpa by stabilizing with Brick Kiln Waste.

Conclusion

From the results of this study, the following conclusions are drowned:

1. The expansive soil was identified to be an A-7-6 soil on AASHTO (1986) classification system and CL as per Unified Soil Classification System (USCS), respectively.
2. Treatment with Brick Kiln Waste showed a general decrease in the MDD and increase in OMC with increase in the Brick Kiln Waste content.
3. UCS value increases as the curing period increases.
4. Observed that UCS value increased from 290 kpa to 569 kpa by stabilizing with Brick Kiln Waste.

References

[1] Arvind kumar, Bajit Singh Walia, Asheet Bajaj; Influence of Flyash,Lime,and Polyester Fibers on Compaction and strength Properties of Expansive soil. 10.1061/(ASCE00899-1561(2007)19:3(242)

[2] K.Jayaganesh, D.Yuvaraj, C.Nitesh,G.karthik ; Effect of bitumen emulsion and sea shell powder in the unconfined compressive strength of black cotton soil. Published in IJERA vol 2, Issue 3, May –Jun 2012.

[3] Dr Robert M.Brooks ; Soil stabilization with Fly Ash and Rice Husk Ash, Vol1, Issue 3, Dec 2009.

[4] Koteswara rao, Pranav; Stabilization of Expansive soil with Rice Husk Ash, Lime and Gypsum. Published in IJEST VOL 3, Nov 2011.

[5] Mehdi Gharib, Hmidreza Saba;The effect of additives on clay soil properties using cement and lime.Vol.,1(3),66-78,2012.

[6] Musa Alhassan; Potentials of Rice Husk Ash for Soil Stabilization. AU J.T. 11(4):246-250, Apr.2008.

[7] Oriola, Moses; Groundnut Shell Ash Stabilisation of Black Cotton Soil. Published in EJGE, Vol 15 2010.

[8] Laxmikanth Yadu, Rajesh Kumar Tripathi, Dharmaveer Singh; Comparision of Fly Ash and Rice Husk Ash stabilized Black cotton soil. Published in Internation journal of Earth Sciences and Engineer Vol 4, Oct 2011.

[9] MusaAlhassan,Alhaji Mohammed MUSTAPHA; Effect of Rice husk ash on Cement Stabilized Laterite.ISSN 1583-1078 Issue 11,July-December 2007

[10] Khandaker M. Anwar Hossain; Stabilized Soils Incorporaing Combinations of Rice Husk Ash and Cement Kiln Dust.10.1061/(ASCE)MT.1943-5533.0000310,2012.

[11] S.Bhuvaneswari, R.G.Robinson,S.R.Gandhi; Stabilization Of Expansive soils using flyash, FAUP,TIFAC,DST, New Delhi-110016.

[12] Fidelis O. OKAFOR[1], Ugochukwu.N.OKONKWO[2]; Effects of Rice Husk Ash on some Geotechnical Properties of Lateritic Soil. ISSN 1583-1078 Issue 11,July-December 2007.

[13] http://www.azgs.state.az.us/GEOHAZARDS/brickkilnwaste/soils_popcorn_.jpg/2/1/ 2013.

[14] The Effect of Additives on Clay Soil Properties Using Cement and Lime, Vol., 1(3), 66-78, 2012.

[15] P.Ramesh,A.V.Narasimha Rao, N.Krishna Murthy, efficacy of sodium carbonate and calcium carbonate in stabilizing a black cotton soil, Volume 2, Issue 10, October 2012.

[16] Basha E.A., Hashim R., Mahmud H.B., Muntohar A.S., Stabilization of Residual with Rice husk ash and cement consturuction and building materials 2005.