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A Study on Geotechnical Properties of Expansive Soil Stabilized with Barite Powder and Aluminium Chloride

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Abstract: Soils pose problems to civil engineers in general and to geotechnical engineers in particular. They cause damage to structure founded in them because of their potential to react to changes in moisture regime. Expansive soils are basically susceptible to detrimental volumetric changes with changes in moisture content causes distortions to the structures constructed on these soils. Utilization of industrial waste materials in the improvement of soils is a cost efficient and environmental friendly method. The properties of the black cotton soils can be altered in many ways viz. mechanical, thermal and chemical means. Therefore, soil stabilization techniques are necessary to ensure the good stability of soil so that it can successfully sustain the load of the superstructure especially in case of soil which is highly active; also, it saves a lot of time. In the present work, an attempt has been made to study the Atterberg's limits, compaction and soaked CBR characteristics tests of black cotton soil mixing with different percentages of Barites Powder and Aluminium Chloride with a view to determine the optimum percentage. Test results shows that stabilizing Expansive Soil with Barites Powder and Aluminium Chloride increases the geotechnical properties and the optimum percentages are 20% and 1.5% respectively.

Keywords: *Expansive Soil, Barites Powder, Aluminium Chloride, Compaction, Soaked CBR*

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I. INTRODUCTION

Expansive soils popularly known as black cotton soils, because of their suitability for growing cotton, cover almost 20% of the geographical land available in India. These deposits, because of the specific physical and chemical makeup, are undergoing volume changes with seasonal variations (Snethen et al., 1975; Chen, 1988). Swelling soils, also known as expansive soils, are ones that swell in volume when subjected to moisture. These swelling soils typically contain clay minerals that attract and absorb water. Civil Engineers face many difficulties when construction activities are to be done in expansive soils such as Black Cotton Soil because of their unconventional behaviour. Soils, which exhibit a peculiar alternate swell-shrink behavior due to moisture fluctuations, are known as expansive soils. This behavior is attributed to the presence of clay minerals with expanding lattice structure. The soil is hard as long as it is dry but loses its stability almost completely on wetting. On drying, the soil cracks very badly and in the worst cases, the width of cracks is almost 150 mm and travel down to 3 m below ground level (Uppal, 1965; Kasmalkar, 1989; Picornell and Lytton, 1989). Many research organizations are doing extensive work on waste materials concerning the viability and environmental suitability. However due to rapid industrialization there exist a problem in the form of waste accumulation and subsequent problems due to their disposal & effects of waste Mine waste causes serious environmental problem, huge quantities of mine waste produced every year by mining industries by dumping of mine wastes. Utilization of mine waste (usable) for the engineering activity reduces the environmental problems to some extent. Several attempts were made for the stabilization of black cotton soil and in many attempts; some of the admixture was carried out for stabilization of black cotton soil like rice husk, flyash, jute, coir, waste plastics, waste tyre rubber, iron powder, silica fumes, and quarry dust, wood ash etc. Gaonkar et al., (2010) were study the geotechnical properties of mine waste to improve the geotechnical properties of the mine wastes. From test results, as the cement content increases, the maximum dry density obtained from proctor test increases to a very small extent and remains almost constant after about 6% of cement, as the cement % increases, UCS increases at a faster rate up to 6%, and there after the rate of increases in strength is less and beyond about 8 to 10% is not advantageous. As the cement content increases, the deviatric stress at failure increases at a faster rate from 3 to 6% and from 6 to 12% the rate of increases becomes very slow and attains almost constant value. As the cement increase the angle of internal friction increase a faster rate for initial values than the rate is lower for intermediate values and again the speed is increased for the further values and cement content increases the axial strain failure decrease by a large amount. Kiran B. Biradar et al., (2014), were studied the performance of crusher dust, flyash and steel slag mixing with different percentages. The effect of all the admixtures on various properties is significant in general and of steel slag in particular. A decrease in consistency limits is observed with admixtures. The composite soil has exhibited lower void ratios with the addition of Quarry dust and Steel slag. The variation of void ratio is same using steel slag and quarry dust admixture is same and flyash content increases void ratios increases. Improvement in compaction characteristics increase in maximum dry density and decrease in OMC with steel slag & quarry dust and an opposite trend with flyash. Both CBR (Soaked) and CBR (Unsoaked) has been improved with admixtures and the improvement is more pronounced in soaked performance over Unsoaked. Performance ratio improved for UCS with the addition of admixtures. 1.18, 1.27 and 1.09 times improvement is observed with addition of Quarry dust, Steel slag and flyash respectively. Mohamad Nidzam Rahmat et al., (2014), were investigate the potential of utilizing POFA and RHA as sustainable stabilizer material as partial replacement of traditional lime and Portland cement. Based on the laboratory results, the use of agricultural waste POFA and RHA as blended binders for soil stabilization and partial replacement of cement or lime. The composition of POFA: PC (50:50) and RHA: PC (50:50) at 20% dosage recorded the highest compressive strength of stabilized soil when clay was incorporated with landfill soil at 50:50 ratios, when landfill soil on its own were stabilized with all blended stabilizer, the strength recorded were half of the strength achieved when clay was incorporate in the system. The result shows that POFA and RHA are capable to replace certain amount of cement and lime in soil stabilization but not in a large scale. RHA are more favorable stabilizer in terms of strength development when combined with PC. The ratio of lime and PC must always be the dominant ingredient for stabilization. Incorporation of agricultural wastes POFA and RHA as stabilizer, tend to absorb high percentage of water compared to control specimen. This shows that although the addition of POFA or RHA assist to increase the compressive strength of stabilized soil but it has a lower durability compared to lime or PC stabilized soil. Bharti Joshi1et al., (2016), were study the stabilization of expansive soil by the industrial waste iron dust as a admixture in black cotton soil in various percentages and studies were carried out to the improvement in geotechnical properties of an expansive soil. The liquid limit values are decreasing with the percentage increase of Iron Powder in the soil, while the Plastic limit remained constant. The Plasticity Index (P.I) decreased with increase in percentage of Iron Powder in Soil. The Maximum dry density increased up to 6% replacement of Iron Powder and decreased further and increase in the percentage of Iron powder in soil is resulting in higher CBR values. From the results it is recommended to replace 6% of Iron Powder in Soil to get maximum dry density, higher CBR Values which are the indicators of Strength of a Soil. In this investigation, different laboratory experiments like Atterberg limits, Compaction and soaked CBR tests were conducted by varying percentages of 0 %, 10 %, 20 %, 30 % of Barites Powder and 0.5 %, 1 %, 1.5 %, 2 % and 2.5 % Aluminium Chloride were blended to the expansive soil and from test results it is found that there is an improvement in geotechnical properties. Testing is conducted with a view to find the optimum percentages Barites Powder and Aluminium Chloride.

II. MATERIALS USED

2.1 Black Cotton Soil

The soil used was a typical black cotton soil collected from, Allavaram, East Godavari District, Andhra Pradesh, India. The black cotton soil was collected by method of disturbed sampling after removing the top soil at 150 mm depth. The soil was air dried and sieved with is sieve 4.75mm as required for laboratory test as shown in fig.1. The soil properties are W_L= 83.4%, W_P = 40.6%, PI = 42.8, I.S. Classification = CH (Clay of high compressibility), OMC = 21.90%, MDD = 1.575kN/m^3, Differential Free Swell = 100 %, Soaked CBR=1.82 %, Specific Gravity = 2.68.

2. 2. Barites Powder (BP)

The Barites Powder Collected from Sri Balaji Micro Pulverizing Mill, SVDC Road, Kadapa was used as a stabilizing material as shown in the fig.2. Barites Powder is mixing in varying percentages of 10 %, 20 %, and 30 % with the Expansive Soil. The Properties of Barite Powder are MDD=8.263 kN/m^3, OMC = 18.94 %, Soaked CBR = 9.46 %.

Fig.1 Expansive Soil

Fig. 2 Barites Powder

Fig. 3 Aluminium Chloride

2.3 Aluminium Chloride ($AlCl_3$)

Aluminium chloride being hygroscopic and deliquescent is used as a water retentive additive mechanically stabilized soil bases and surfacing. The vapor pressure gets lowered, surface tension increases and rate of evaporation decreases. The freezing point of pure water gets lowered and it results in prevention or reduction frost heave. The depressing of fine grained soils. Aluminium chloride acts as a soil flocculent and facilitates the electric double layer, the salts reduces the water pick up and thus the loss of strength compaction. Commercial grade $AlCl_3$ is used for this study as shown in the fig.3. The quantity of chemical was varied from 0 to 2.5 % by dry weight of soil.

III. EXPERIMENTAL INVESTIGATION

To find the effectiveness of Barites Powder and Aluminium Chloride blending in expansive soil various tests were carried out in the laboratory for finding the index and other important properties used during the study. The overall testing program is conducted in two phases. In first phase, black cotton soil was stabilized with barites powder mixed with different percentages, i.e. 10%, 20% and 30% by weight was used for preparing different samples. Atterberg's limits, modified proctor compaction test and soaked California Bearing Ratio (CBR) tests were conducted with a view to determine the optimum percentage. In second phase black cotton soil with 20 % of optimum barites powder from first phase results was stabilized by adding different percentages of Aluminum Chloride varied from 0.5 %, 1 %, 1.5 %, 2 % and 2.5 % by weight was used for preparing samples. Atterberg's limits, modified proctor compaction tests followed by soaked California Bearing Ratio (CBR) tests were conducted to know the improvement in geotechnical and strength characteristics expansive soil treated with barites powder and aluminum chloride when compared to untreated expansive soil.

3. 1. Index Properties

Standard procedures recommended in the respective I.S. Codes of practice [IS:2720 (Part-5)-1985; IS:2720 (Part-6)-1972], were followed while finding the Index properties viz. Liquid Limit and Plastic Limit of the samples tried in this investigation.

3. 2. Compaction Properties

Optimum moisture content and maximum dry density of black cotton soil and stabilized Black cotton soil with different percentages of Barites Powder and Aluminum Chloride mixes were determined according to I.S heavy compaction test IS: 2720 (Part VIII).

3. 3. California Bearing Ratio (CBR) Tests

Different samples were prepared for CBR test using expansive soil material mixing with different percentages of Barites Powder and Aluminum Chloride with a view to determine optimum percentages. The CBR tests were conducted in the laboratory for all the samples as per IS Code (IS: 2720 (Part-16)-1979) under soaked condition.

IV. RESULTS AND DISCUSSION

Various tests were conducted in the laboratory as per I S Code provisions and the test results are furnished below with a view to determine the optimum percentages.

4. 1. Consistency Characteristics

Liquid limit and the plastic limit values were reduced from 83.4, 74.6, 70.8 and 69.2 and 40.6, 38.8, 36.5 and 34.9 by adding 0 %, 10 %, 20 % and 30 % of barite powder respectively when blended with the expansive soil as shown in the Fig. 4. Liquid limit and the plastic limit values were reduced from 70.4, 68.3, 67.5, 67.2 and 67.1 and 35.4, 34.5, 36.5 and 31.8, 31.6 and 31.2 by adding 0.5 %, 1.0 %,1.5 %, 2.0 % and 2.5 % of aluminum chloride blended with the expansive soil and 20% optimum percentage of barite powder as shown in the Fig. 5.

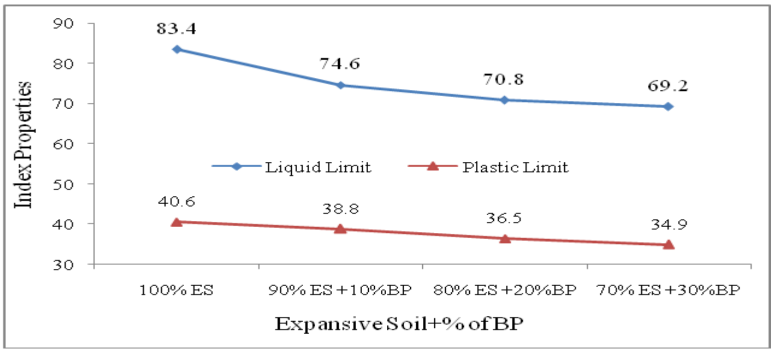

Fig. 4 Variation of Consistency Limits of Expansive Soil Treated with Different Percentages of Barites Powder

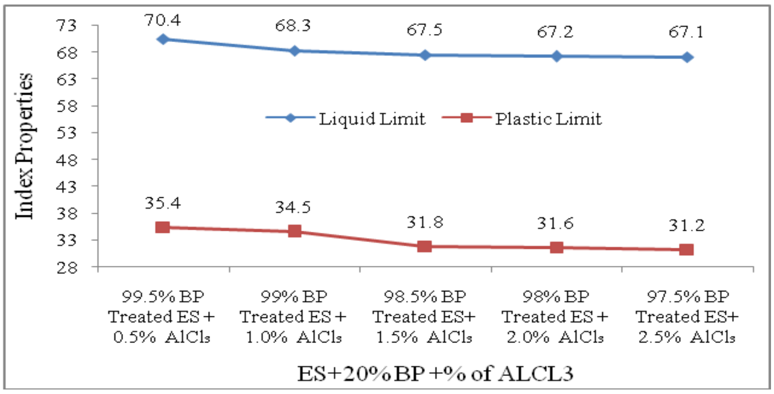

Fig. 5 Variation of Consistency Limits of Expansive Soil + 20% of Barites Powder with Different Percentages of Aluminum Chloride

4. 2. Compaction Test

From the compaction test results the maximum dry density values are increases from 15.75 kN/m^3, 17.05 kN/m^3, 17.41 kN/m^3 up to 20% addition of barite powder and decreased to 17.34 kN/m^3 at 30% barite powder and the optimum moisture content values are decreasing from 21.9%, 19%, 18.5%, and 18% respectively when the soil is mixed with 0 %, 10 %, 20 % and 30 % of barite powder as shown in the Fig. 6. The optimum percentage of barite powder 20%. The decrease in optimum moisture content is attributed to the fact that additional water held within the flocs resulting from flocculation. From Fig.7 it is observed that, the OMC values are increasing from 18.95 %, 19.83 %, 21.08 %, 22.67 % and 23.33 and the MDD values are varied from 17.41, 17.64, 17.82, 17.71 and 17.56 respectively with the addition of 0.5 %, 1.0 %, 1.5 %, 2.0 % and 2.5 % of aluminum chloride blended with the expansive soil and 20% optimum percentage of barite powder.

4. 3. California Bearing Ratio (CBR) Test

Soaked CBR tests were conducted for expansive soil mixed with different percentages of barites powder and Aluminum Chloride and the results were presented in the Figs. 8&9. It is observed from that expansive soil mixed with different percentages of barites powder the soaked CBR values are 1.82,2.71,4.03 and 3.92 for 0 %, 10 %, 20 % and 30 % of barites powder and 4.75,5.92,7.05,6.54 and 5.62 for 0.5 %, 1.0 %, 1.5 %, 2.0 % and 2.5 % of aluminum chloride blended with the expansive soil and 20 % optimum percentage of barite powder respectively.

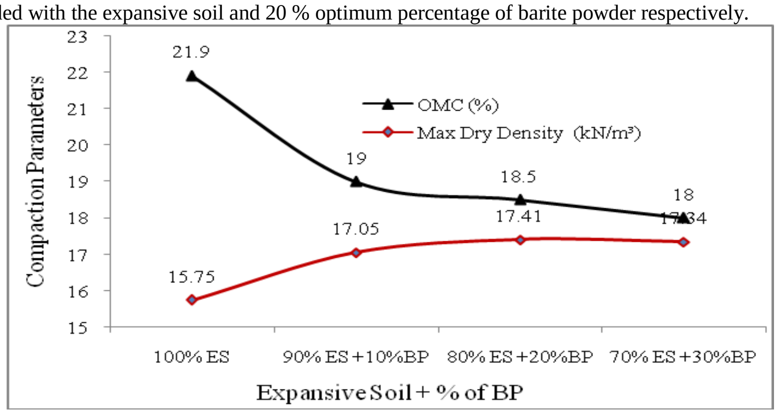

Fig. 6 Variation of Compaction Parameters of Expansive Soil Treated with Different Percentages of Barites Powder

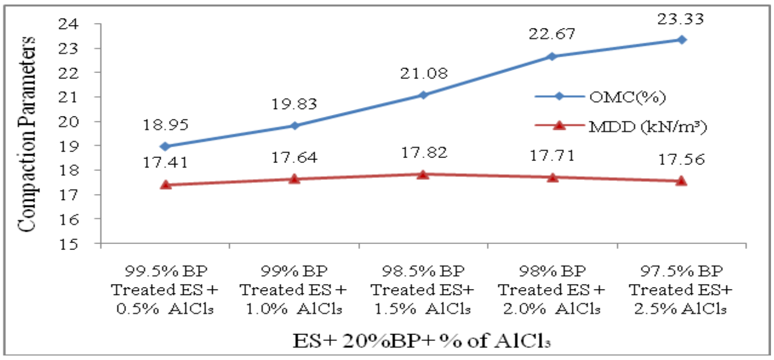

Fig. 7 Variation of Compaction Parameters of Expansive Soil + 20% of Barites Powder with Different Percentages of Aluminum Chloride

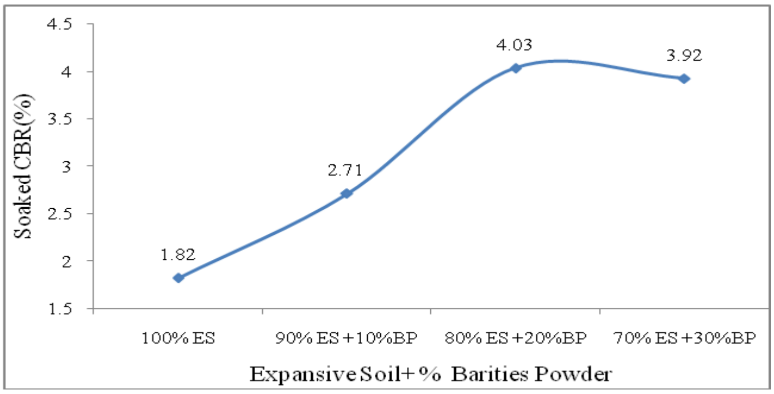

Fig. 8 Variation of Soaked CBR Values of Expansive Soil Treated with Different Percentages of Barites Powder

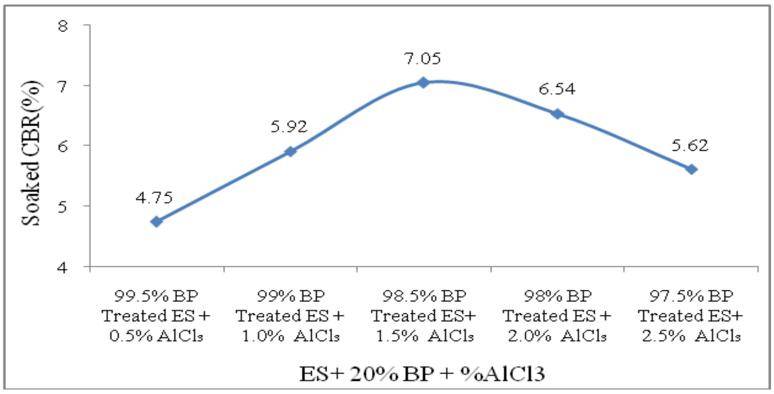

Fig. 9 Variation of Soaked CBR Values of Expansive Soil + 20% of Barites Powder with Different Percentages of Aluminum Chloride

V. CONCLUSION

The following conclusions are obtained based on the laboratory studies carried out in this investigation. From the laboratory studies, it is observed that the liquid limit of the expansive soil has been improved by 31.7 % with the addition of 20 % BP and further the liquid limit of 20% BP treated expansive soil has been improved by 41.73 % with the addition of 1.5% $AlCl_3$ when compared with the untreated expansive soil. Plasticity Index of the expansive soil has been improved by 71.75 % with the addition of 20% BP and further the Plasticity Index of 20% BP treated expansive soil has been improved by 95.5% with the addition of 1.5% $AlCl_3$ when compared with the untreated expansive soil. From the laboratory studies, it is observed that the CBR values of the expansive soil has been improved by 142.58% with the addition of 20 % BP and further the CBR value of 20% BP treated expansive soil has been improved by 289.56 % with the addition of 1.5 % $AlCl_3$ when compared with the untreated expansive soil. Hence the optimum percentages of Barites Powder and Aluminum Chloride are 20% and 1.5% respectively. By the addition of barite powder waste in the poorly graded soil may improve the geotechnical properties of soil and also by using waste as an admixture it can reduce the cost of stabilization process. The utilization of the industrial wastes Stabilization works will help in solving the environmental pollution problems associated with the disposal

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REFERENCES

[1] Bharti Joshi, Ashutosh Sharma, Hitesh Sharma, Abhijeet Singh (2016), “Stabilization of Black Cotton Soil by Iron Powder”, SSRG International Journal of Civil Engineering (SSRG-IJCE) – volume 3 Issue 7 – July 2016, ISSN: 2348 – 8352, Pp. 87-90.

[2] Chen, F. H. (1988), “Foundations on expansive soils”, Chen & Associates, Elsevier Publications, U.S.A.

[3] Gaonkar, G.U.G. Fernandes, W. Vajrala, A.R (2010),” Stabilization of Typical Mine Wastes of Goa, Indian Geotechnical Conference – 2010, GEOtrendz, December 16–18, pp.633-636.

[4] Kasmalkar, B.J., “Foundation Engineering”, Vidyardhi Griha Prakasam, Pune, 1989.

[5] Kiran B. Biradar, V. K. Chakravarthi, U. Arun Kumar (2014), “Efficacy of Industrial waste admixture in Improving Engineering Performance of Clayey soil – A quantitative study” American Journal of Engineering Research (AJER) e-ISSN: 2320-0847 p-ISSN: 2320-0936 Volume-3, Issue-9, pp-251-263.

[6] Picornll, M. and Lytton, R.L., “Field Measurement of Shrinkage Crack Depth in Expansive Soils, TRR-1219, TRB, 1989, pp.121-130.

[7] Mohamad Nidzam Rahmat, Muhammad Redzwan Raffe, Norsalisma Ismail (2014), "Utilization of Agricultural Wastes in Stabilization of Landfill Soil", MATEC Web of Conferences-2014.
[8] Snethen, D.R. et al., "A Review of Engineering Experiences with Expansive Soils in Highway Subgrades", Interim Report, Prepared for Federal Highway Administration, U.S. Department of Transportation, Washington, 1975.
[9] Uppal, H.L., "Field Study on the Movement of Moisture in Black Cotton Soils Under Road Pavements", symposium on Moisture Equilibria and Moisture Changes in Soils Beneath Covered areas, Butterworths, Australia, 1965, pp. 687-693.

G D N Santhoshi. "A Study on Geotechnical Properties of Expansive Soil Stabilized with Barite Powder and Aluminium Chloride." IOSR Journal of Engineering (IOSRJEN) , vol. 7, no. 9, 2017, pp. 66–71.