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Bottom ASH as an Additive Material for Stabilization of Expansive Soil

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Abstract:

Nowadays Expansive soils are a worldwide problem for civil engineers. It causes damages to foundations, pavements etc. Due to disposal of plastic waste on soil and pollution, it reduces soil strength and causes various problems on soil. Soil stabilization is the way used to reduce problems in expansive soils. The present project describes about the properties of expansive soil and bottom ash. Bottom ash is used as an additive material for stabilizing the soil. Stabilizing the soil by adding Bottom ash improves the soil strength and reduces swell and shrink. The main aim of this project is to study the effect of bottom ash on expansive soil for road construction. The laboratory tests are carried to determine the index properties and engineering properties of soil sample. The soil samples are prepared with different proportions of bottom ash as 5%, 10%, 15%, 20%, 25%, 30%. This proportion was used for further tests such as Atterberg's Limit test, Standard Proctor Compaction test (SPC), Unconfined Compressive Strength test (UCC), and California Bearing Ratio test (CBR). This project shows that bottom ash improves the soil strength.

Keywords: Expansive soil, Bottom ash, Soil stabilization, Road construction.

1. INTRODUCTION

The growth of the population has created a need for better and economical vehicular operation which requires good highway having proper geometric design, pavement condition and maintenance. Cost effective roads are very vital for economical growth in any country. There is an urgent need to identify new materials to improve the road structure and to expand the road network. Expansive soils are soils or soft bedrock that increases in volume or expand as they get wet and shrink as they dry out. Black cotton soils are problematic for engineers everywhere in the world. This investigation is done on black cotton soil by using coal bottom ash to improve its strength for road construction. Extensive laboratory / field trials have been carried out by various researches and have shown promising results for application of such expansive soil after stabilization with additives such as sand, silt, lime, fly ash, etc. As Bottom ash is available at very lower cost, for projects in the vicinity of a Thermal Power Plants, it can be used for stabilization of expansive soils. Coal-based thermal power plants all over the world face serious problems of handling and disposal of the ash produced. At present, about 80 thermal power stations produce nearly 100 million tons of coal ash per annum. Safe disposal of the ash without harmfully affecting the environment and the large storage area required are major concerns. In this investigation, characteristics of soil stabilized with bottom ash are investigated. Geotechnical

properties of clay such as Atterberg's limits, compaction characteristics, unconfined compression strength are determined. Bottom ash is added to soil in varying proportions of 5%, 10%, 15%, 20%, 25%, 30%.

1.1 OBJECTIVE

The main objective of the proposed project is

- To study the change of geotechnical properties of the expansive soils by stabilizing with bottom ash
- To analyze the results and make appropriate recommendations for optimal use
- To study the effects of bottom ash and decreasing the permeability of soil

2. METHODOLOGY

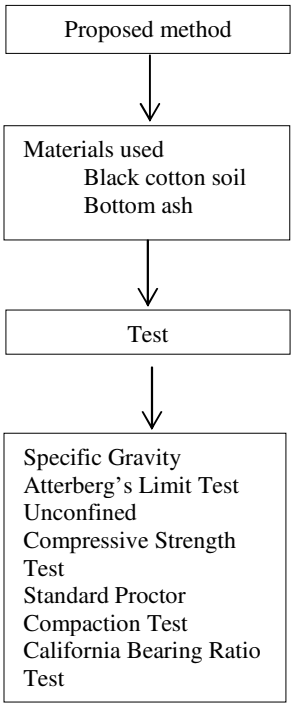

Fig 2.1 Methodology

2.1 Collection of Materials

2.1.1 Collection of soil

The expansive soil (Black cotton soil) used for this project was taken from Erode District. The locations had been selected for collecting one soil sample from the particular area. The black cotton soil was collected from a depth of 1m.

Table 2.1 Properties of soil

Size	Below 0.002 mm
Specific Gravity	2 to 3
Colour	Black
Permeability	Low
Liquid Limit	47%
Plastic Limit	17%

2.1.2 Collection of Bottom ash

Bottom ash is obtained from Thermal Power Plant, Erode District.

Table 2.2 Chemical Properties of Bottom ash

SiO_2	51.36
Al_2O_3	23.14
Fe_2O_3	7.32
CaO	1.27
MgO	0.54
SO_3	0.08
K_2O	2.79

3. TEST RESULTS

3.1 Atterberg's Limit

Liquid Limit and Plastic Limit were conducted on the soil without and with bottom ash. The different proportions of bottom ash added in the soil was 0%, 5%, 10%, 15%, 20%, 30%. This test is done to determine the plastic limit and liquid limit of soil as per IS:2720 (Part 5) - 1985.

3.1.1 Liquid Limit

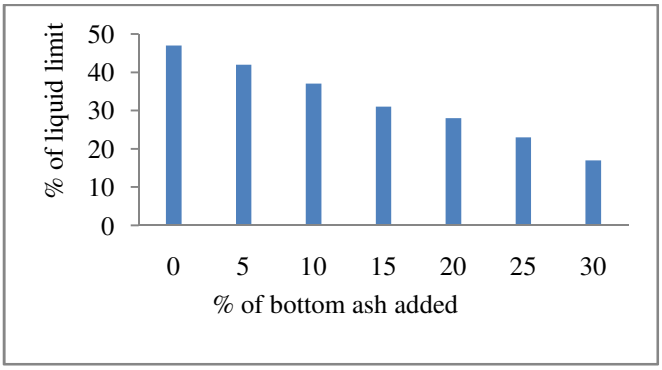

Fig 3.1 Liquid Limit test

3.1.2 Plastic Limit test

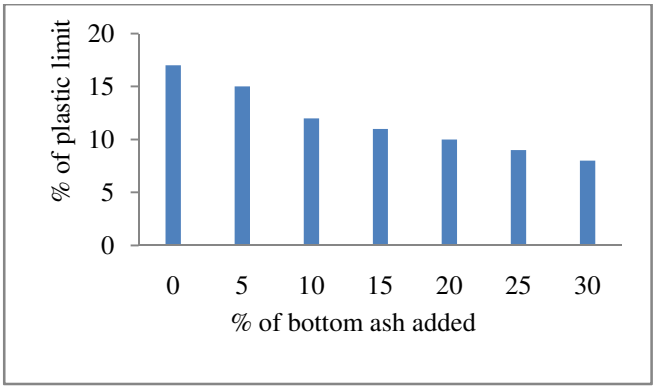

Fig 3.2 Plastic Limit test

3.2 Unconfined Compressive Strength Test

The Unconfined Compressive Strength Test is used to measure Undrained Shear Strength.

Table 3.1 Unconfined Compressive Strength Test

% of Bottom ash added	Unconfined Compressive Strength (kN/m^2)	Undrained Shear Strength (kN/m^2)
0	198.25	99.12
5	248.81	124.405
10	298.43	149.21
15	315.87	157.93
20	360.25	180.12
25	246.25	123.12
30	216.73	108.36

3.3 Standard Proctor Compaction Test

The Standard Proctor Compaction Test is used to determine the maximum dry density and optimum moisture content. The analysis is carried out for the soil with different proportions of 0%, 5%, 10%, 15%, 20%, 25%, 30% of addition of bottom ash.

Table 3.2 Standard Proctor Compaction test

% of Bottom ash added	Maximum dry density (g/cc)
0	2.21
5	2.31
10	2.34
15	2.37
20	2.38
25	2.41
30	2.46

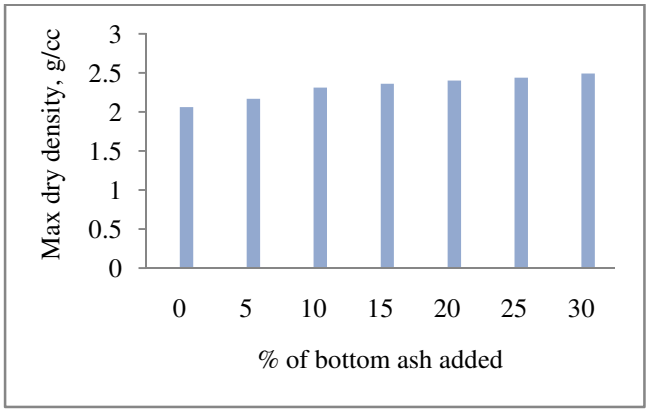

Fig 3.3 Maximum dry density

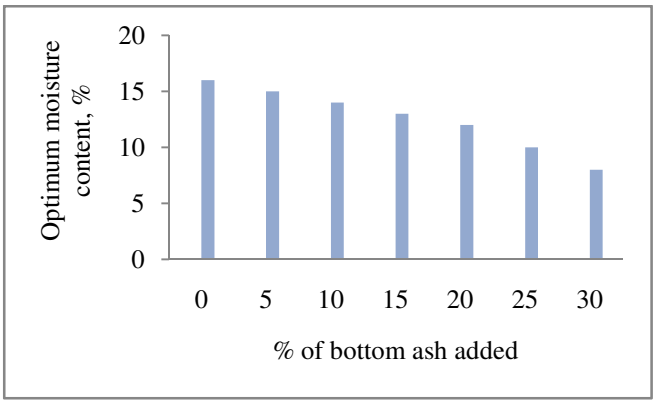

Fig 3.4 Optimum moisture content

3.4 California Bearing Ratio

The California Bearing Ratio test is used to measure the bearing capacity of soil and are used in pavement design. The penetration value is carried out on 2.5mm and 5mm.

Table 3.3 California Bearing Ratio test

% of bottom ash added	Penetration value (mm)	
	2.5 mm	5 mm
0	2.14	3.73
5	3.34	4.17
10	4.17	5.31
15	5.91	5.44
20	6.78	7.23
25	7.78	7.39
30	8.89	9.76

4. CONCLUSION

In this project we are observe to the samples are tested by various tests such as Index property test, Unconfined Compressive Strength test, Standard Proctor Compaction test, California Bearing Ratio test.

The plastic limit and liquid limit value of addition of 30% of bottom ash on soil is less than the conventional.

The Standard Proctor Compaction test is used to determine the maximum dry density and optimum moisture content. By the addition of 30% bottom ash, the value of maximum dry density is greater than the conventional.

The Unconfined Compressive Strength test is used to determine the strength of the soil. By the addition of 30% bottom ash, the value of compressive strength is greater than the conventional.

The California Bearing Ratio test is used to determine the thickness of subgrade of the soil. By the addition of 20% of bottom ash, the value of CBR is greater than the conventional.

By the addition of 30% of bottom ash on expansive soil (Black cotton soil) improves the geotechnical properties of soil.

5. REFERENCES

1. Dheebhikaa, B. and Raja, K. (2017) “Effect of bottom ash / pond ash as replacement of fine aggregate in cement concrete” .
2. Manikandan, A.T. and Ibrahim, Y. (2017) “A study on effect of bottom ash and coconut shell powder on the properties of clay soil”.

3. Bachhav, S.S. and Baviskar, K.R. (2016) "Stabilization of local expansive soil with fly ash and Cement".
4. Meenambal, T. and Rajakumar, C. (2015) "Experimental Study on Utilization of Bottom Ash to Stabilize Expansive Soil Subgrades".
5. Abhijith, R.P. (2015) "Effect of Natural Coir fibers on CBR Strength of Soil Subgrade" Department of Civil Engineering, Marian Engineering college, Trivandrum, India.
6. Dharmendra Kumar, Sudhir Nigam, AbhinavNangia, and Shailendra Tiwari, (2015) "California Bearing Ratio Variations in Soil Reinforced With Natural Fibres" A Case Study Bhopal Bypass Road" in International Journal on Emerging Technologies 6(2): 95-104(2015). LNCTS Bhopal, (MP), INDIA.
7. Monica Malhotra,Sanjeev Naval , (2013) "Stabilization of Expansive Soils Using Low Cost Materials".
8. Lakshmi Keshav, Mangaiarkarasi.V, (2012) "Effect of Fly Ash on an Expansive Soil for Flexible Pavement Design".
9. Enokela, O.S. and Alada, P.O. (2012) "Strength analysis of coconut fibre stabilized earth for farm structures" International Journal of Advancements in Research & Technology, Volume 1, Issue2, July-2012 1ISSN 2278-7763 Makurdi - Nigeria.
10. Joseph, kimetu, M. and Johannes Lehmann, (2010) "Stability and stabilization of biochar and green manure in soil with different organic contents" Australian journals of soil research, 2010, 48, page (577-585), ISEEE, Canada.
11. Ravi shankars, A.U. and harsaha kumar. (2009) "Bio-enzyme stabilized lateritic soil as a highway material" Journal of indian roads congress, July – September 2009page (143 – 152) Karnataka.
12. Vaidya, M.K., Chore, H.S., Kousitha, P. and Ukrande, S.K. (2006) "Geotechnical Characterization cement - fly ash –fibers mix" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684, PP: 60-66 University of Mumbai, India.