JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

IMPACT OF THE ADDITION OF FLY-ASH AND STONE DUST ON THE INDEX PROPERTIES OF BLACK COTTON SOIL OF SAURASHTRA REGION

[1]Krushnadevsinh G. Rana, [2]Prof. M. G. Vanza
[1]P.G. student, [2]Associate professor,
[1]Applied Mechanics Department,
[1]L.D College of Engineering, Ahmedabad, India.

Abstract: In countries like India, rapid industrialization coupled with limited available land has led to a growing demand for the utilization of industrial waste materials. From a geotechnical perspective, various industrial by-products such as fly ash, granite and quarry waste, cement kiln dust, silica fume, and rice husk possess advantageous properties ideal for soil stabilization purposes. Utilizing these waste materials for stabilization is a viable method for enhancing the engineering properties of soil and rendering it suitable for construction applications. This paper provides an overview of recent trends in the stabilization of expansive soil using Fly ash and stone dust to improve the index properties of black cotton soil, aimed at mitigating environmental risks associated with soil instability. In this research work 5,10,15% of fly ash along with the variation of stone dust 10,20,30% is added to the soil for stabilization. The Standard proctor test, Grain size analysis, Liquid limit (LL), Plastic limit (PL), Specific Gravity and Free swell Index (FSI) were performed on black cotton soil. The MDD value for soil is 1589.65 kg/m^3 which is increased to 1842.89 kg/m^3 with the addition of 15% fly ash and 30% stone dust, and the OMC value of soil was 21.97% which was decreased to 16.23% with the addition of 15% fly ash and 30% stone dust. The liquid limit of soil was initially 87% which was reduced to 44.7% with the addition of 15%FA and 30% SD. The plastic limit of soil was initially 38.29% which was reduced to 24.48% with the addition of 15% FA and 30% SD.

Index Terms **– Soil Stabilization, Black cotton Soil (BCS), Fly ash (FA), Stone dust (SD), Liquid limit (LL), Plastic limit (PL).**

1. INTRODUCTION

The term “hidden disaster” refers to the expansive soil’s potential volume change associated with moisture change. The volume change can either increase (e.g. swell) under low applied stress or decrease (e.g., collapse) under high applied stress. In addition, because of the increase in moisture, the loss of shear strength also occurs. These volumetric variations can lead to damage to structures constructed on or in expansive soil. Damage can range from small cracking to irreparable damage to structural components. If damage occurs frequently, repair and maintenance costs can exceed the cost of the initial construction of the structure. Structural damage caused by expansive soils has been estimated to cost more than twice as much as damage caused by floods, hurricane, tornadoes, and earthquakes combined. When faced with expansive soil deposits on construction sites, designers typically have two options: (a) Complete or partially replace these layers; or (b) Remediate existing soil deposits using one of the soil improvement techniques.

Soil stabilization is a topic that has been studied extensively over the last few decades. However, most of the research has focused on traditional soil stabilization agents. However, due to the growing demand for construction and the high cost of construction, or the low availability of quality material in nearby locations, new economical methods must be explored. In India, black cotton soil is found in many states and in some of its areas under villages. In villages, where funds are limited or conventional soil stabilization agents are not of good quality, in such cases, we need to explore new economical methods. Conventional stabilizers take a long time to cure, and with the growing demand and rapid growth in the country, there is a need to explore new methods that can speed up the construction process. Soil stabilization methods new soil stabilization materials in recent years, researchers are conducting research on new, non-conventional, soil stabilization materials. Most of these materials are from industrial or agricultural waste, and most of the research work on these new, non-traditional, soil stabilizers focus mainly on the strength and swelling properties and results of the black cotton soil, but there are still some engineering properties that black cotton soil does not possess. We need a focus on the mechanism of soil stabilization. Impact of Nonconventional Soil Stabilizers on the environment in the short and long term.

2. MATERIALS

2.1 Black Cotton Soil

The Black cotton soil was collected from Bhavnagar district of Gujarat state. The soil was collected from 3m depth from the ground surface. Then the index properties test was carried out in the laboratory. The percentage of fine was found to be more than 90% by wet sieve analysis. The MDD value of soil was 1589.65 kg/m^3 and the OMC of soil was 21.97%. Liquid limit and plastic limit of soil was 87% and 38.29% respectively.

Figure 1 Black Cotton soil

2.2 Fly ash

Fly ash is a fine powder that is a byproduct of burning Pulverized coal in electric generation power plants. It is one of the most widely used coal combustion products (CCPs) and is usually prevented from escaping into the atmosphere by baghouses or electrostatic precipitators. Fly ash is mostly composed of glassy, spherical particles with some crystalline minerals and unburned carbon mixed in. Fly ash primarily comes in two varieties (a) Class F (b) Class C. In this research the fly ash was used of Class F grade and was collected from local vendor in Ahmedabad. Chemical composition of fly ash is shown in below table:

Table 1 Composition of Fly ash

Sr. No	Content	% Quantity
1	Sio_2	49.5-54.5
2	Al_2O_3	25.3-33.8
3	Fe_2O_3	6.8 – 8
4	CuO	3.6 – 7.6
5	TiO_2	2.4 – 3.2
6	K_2O	0.8 – 1.7
7	Cao	0 – 1.3

Figure 2 Fly ash

2.3 Stone dust

The byproduct of crushing rock into smaller aggregate particles during quarrying operations is quarry dust, sometimes referred to as stone dust or crusher dust. It is made up of small pieces of rock and finely crushed stone, usually left behind after basalt, granite, or limestone are crushed. The stone dust used in this research was collected from Shree stone Quarry Botad, Gujarat.

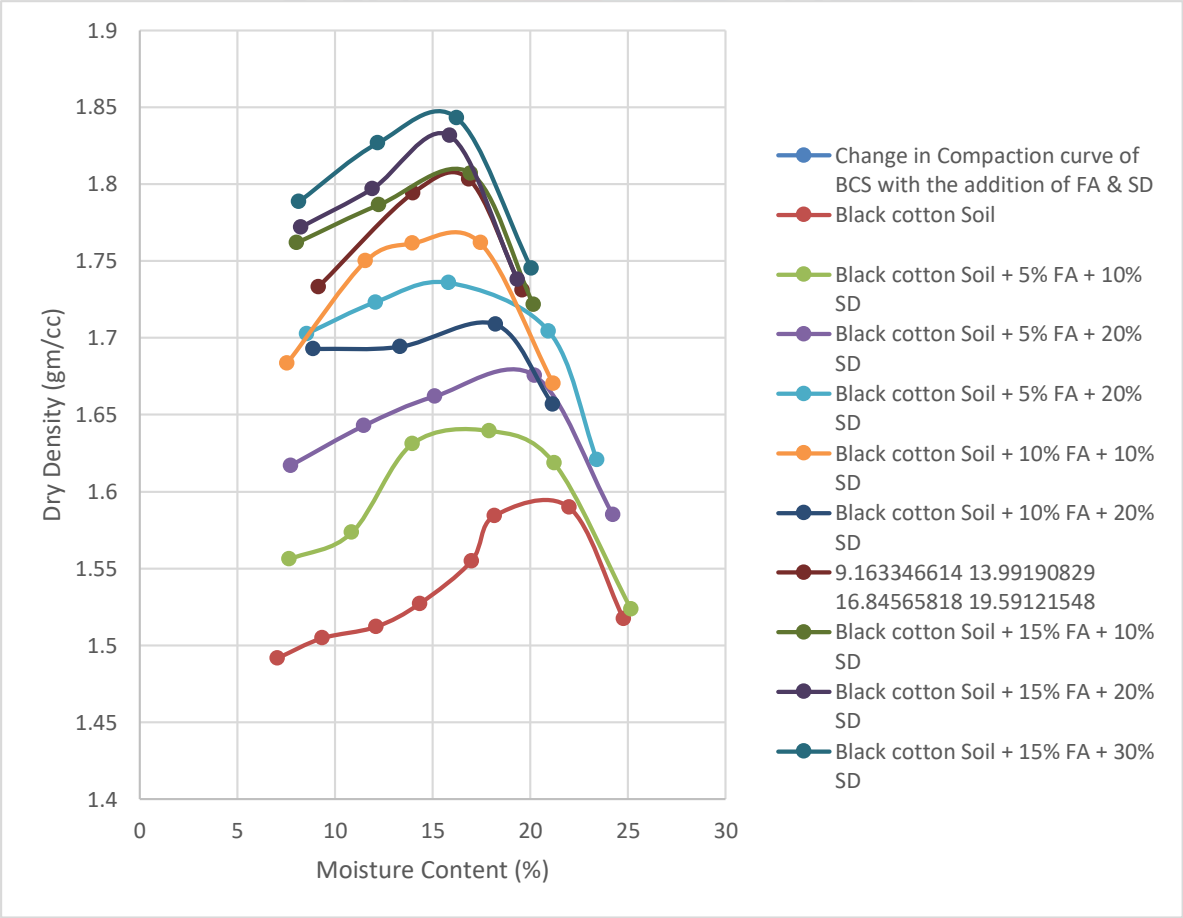
Figure 3 Stone Dust

3. LABORATORY INVESTIGATION PROGRAMME

3.1 Standard Proctor Test

The standard proctor test was performed as per specifications given in [IS 2720 (part-7)-1980]. Fly ash in the percentage of 5%, 10% and 15% along with percentage of stone dust 10 to 30% in the variation of 10% is added in black cotton soil and then the test was performed with different percentage of stabilizing material.

Figure 4 Relation between OMC & MDD of BCS + FA+SD



The MDD value for soil is 1589.65 kg/m^3 which is increased to 1842.89 kg/m^3 with the addition of 15% fly ash and 30% stone dust, and the OMC value of soil was 21.97% which was decreased to 16.23% with the addition of 15% fly ash and 30% stone dust.

3.2 Atterberg's Limit

3.2.1 Liquid limit

The Liquid limit test was performed as per specifications given in [IS 2720 (part-5)-1985]. Fly ash in the percentage of 5%, 10% and 15% along with percentage of stone dust 10 to 30% in the variation of 10% is added in black cotton soil and then the test was performed with different percentage of stabilizing material.

Figure 5 Liquid limit comparision

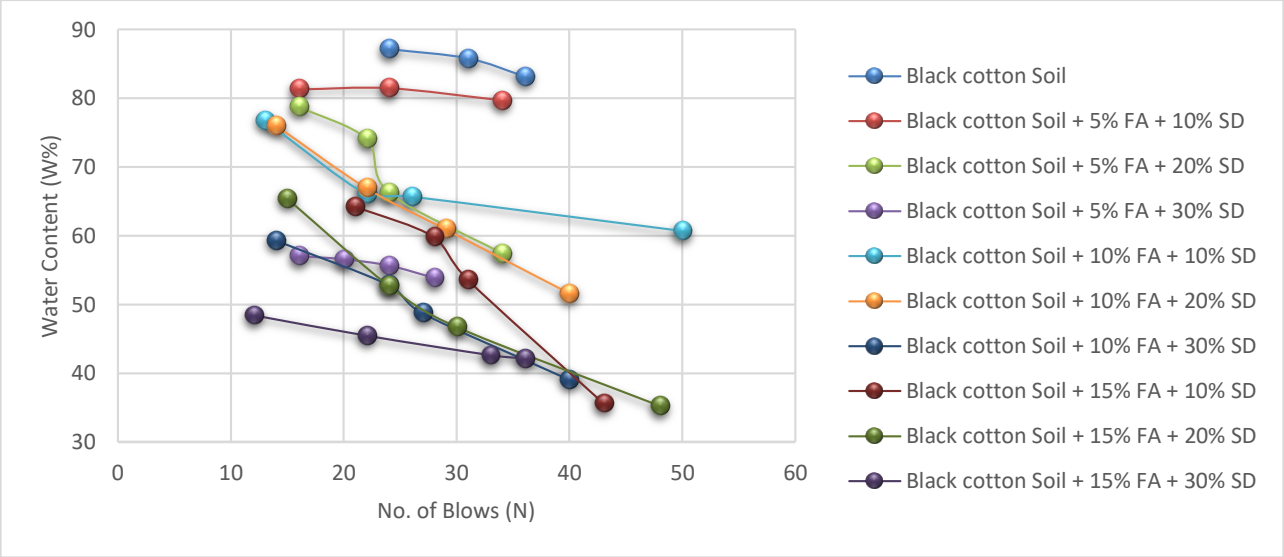


Table 2 Liquid limit

Content	Liquid limit (%)
Black cotton Soil	87.5
Black cotton Soil + 5% FA + 10% SD	81
Black cotton Soil + 5% FA + 20% SD	65
Black cotton Soil + 5% FA + 30% SD	54.5
Black cotton Soil + 10% FA + 10% SD	65.3
Black cotton Soil + 10% FA + 20% SD	63
Black cotton Soil + 10% FA + 30% SD	52.83
Black cotton Soil + 15% FA + 10% SD	61.13
Black cotton Soil + 15% FA + 20% SD	52.70
Black cotton Soil + 15% FA + 30% SD	45.38

3.2.2 Plastic limit

The Plastic limit test was performed as per specifications given in [IS 2720 (part-5)-1985]. Fly ash in the percentage of 5%, 10% and 15% along with percentage of stone dust 10 to 30% in the variation of 10% is added in black cotton soil and then the test was performed with different percentage of stabilizing material. Values obtained from different stabilization material with black cotton soil is shown in below table:

Table 3 Plastic limit

Content	Plastic limit (%)
Black cotton Soil	38.84
Black cotton Soil + 5% FA + 10% SD	29.67
Black cotton Soil + 5% FA + 20% SD	40.64
Black cotton Soil + 5% FA + 30% SD	35.62
Black cotton Soil + 10% FA + 10% SD	30.10
Black cotton Soil + 10% FA + 20% SD	28.03
Black cotton Soil + 10% FA + 30% SD	25.56
Black cotton Soil + 15% FA + 10% SD	29.86
Black cotton Soil + 15% FA + 20% SD	26.39
Black cotton Soil + 15% FA + 30% SD	24.48

3.3 Specific gravity

The Specific gravity test for black cotton soil was performed as per specifications given in [IS 2720 (part-3)-1980]. The results obtained from the test is shown in table 4.

Figure 6 Specific gravity

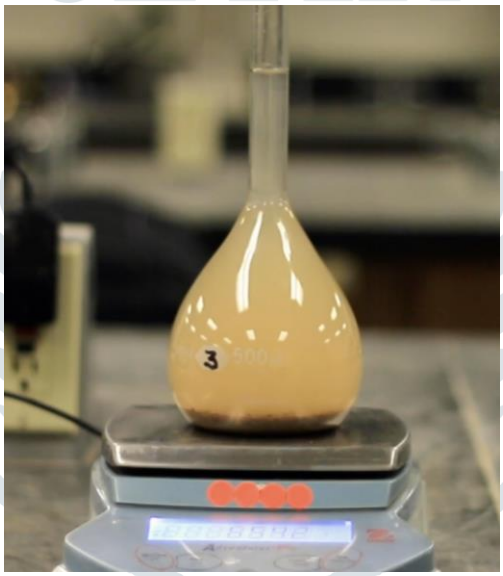


Table 4 Specific Gravity

Sr no.	Weight of Empty Bottle (W1)	Weight of Empty Bottle + Dry Soil (W2)	Weight of Bottle + Soil +Water (W3)	Weight of Bottle filled with water (W4)	Specific Gravity (G)
1	25.88	39.05	81.52	73.29	2.6659
2	25.64	43.61	90.01	78.65	2.7186
3	25.64	41.07	88.27	78.61	2.6741
4	25.88	40.02	82.18	73.36	2.6578
5	25.87	39.72	81.82	73.23	2.633
	Average Specific Gravity				**2.67**

4. CONCLUSION

The MDD value for soil is 1589.65 kg/m^3 which is increased to 1842.89 kg/m^3 with the addition of 15% fly ash and 30% stone dust, and the OMC value of soil was 21.97% which was decreased to 16.23% with the addition of 15% fly ash and 30% stone dust. The liquid limit of soil was initially 87% which was reduced to 44.7% with the addition of 15%FA and 30% SD. The plastic limit of soil was initially 38.29% which was reduced to 24.48% with the addition of 15% FA and 30% SD. The plastic limit of soil was initially 38.84% which is decreased to 24.48% with the addition of 15% fly ash and 30% stone dust.

REFERENCES

1) Bhoi, M. K., Sharma, R., & Kakadiya, H. (2021). Study of Engineering Properties of Expansive Soil Stabilized with Quarry Dust and Fly Ash. In Proceedings of the Indian Geotechnical Conference 2019: IGC-2019 Volume IV (pp. 75-83). Springer Singapore.
2) Khare, A., Gupta, S. K., Sah, S., Kumar, M., Toppo, A., Jain, A., & Jaiswal, S. K. (2023). Implication of Fly Ash in Stabilizing Expansive Soil. Intersect: The Stanford Journal of Science, Technology, and Society, 16(2).
3) Basack, S., Goswami, G., Khabbaz, H., Karakouzian, M., Baruah, P., & Kalita, N. (2021). A comparative study on soil stabilization relevant to transport infrastructure using bagasse ash and stone dust and cost effectiveness. Civil Engineering Journal, 7(11), 1947.
4) Bilal, M., & Ahmad, N. (2020). Effectiveness of Stone Dust as an Expansive Soil Stabilizer. In 2nd Conference on Sustainability in Civil Engineering (CSCE'20), Capital University of Science and Technology, Islamabad Pakistan.
5) Venkateswarlu, H., Prasad, A. C. S. V., Prasad, D. S. V., & Raju, P. G. (2015). Study on behavior of expansive soil treated with quarry dust. International Journal of Engineering and Innovative Technology, 4(10), 193-196.
6) Dixit, M. S., & Patil, K. A. (2016). Utilization of stone dust to improve the properties of expansive soil. International Journal of Civil Engineering and Technology (IJCIET), 7(4), 440-447.
7) Muthu Kumar, M., & Tamilarasan, V. S. (2015). Experimental study on expansive soil with marble powder. Int J Eng Trends Technol, 22(11), 504-507.
8) Abdelkader, H. A., Hussein, M. M., & Ye, H. (2021). Influence of waste marble dust on the improvement of expansive clay soils. Advances in Civil Engineering, 2021, 1-13.
9) Sridharan, A., Soosan, T. G., Jose, B. T., & Abraham, B. M. (2006). Shear strength studies on soil-quarry dust mixtures. Geotechnical & Geological Engineering, 24, 1163-1179.
10) Ramadas, T. L., Kumar, N. D., & Aparna, G. (2010, December). Swelling and strength characteristics of expansive soil treated with stone dust and fly Ash. In Indian geotechnical conference-2010, GEOtrendz (pp. 16-18).
11) Gupta, C., & Sharma, R. K. (2014). Influence of marble dust, fly ash and beas sand on sub grade characteristics of expansive soil. Journal of Mechanical and Civil Engineering, 13, 13-18.
12) Sowjanya, K., Navya, G., Deepika, C., & Mahesh, Y. Performance of Geotechnical Properties of Fly Ash and Quarry dust Mixtures for use in Highway Embankments with varying.
13) Thirumalai, R., Babu, S. S., Naveennayak, V., Nirmal, R., & Lokesh, G. (2017). A review on stabilization of expansive soil using industrial solid wastes. Engineering, 9(12), 1008-1017.
14) Indiramma, P., & Sudharani, C. (2016). Use of quarry dust for stabilising expansive soil. International journal of innovative research in science, engineering and technology, 5.
15) IS: 2720 (Part 5), 1985. Determination of liquid limit and plastic limit, Bureau of Indian standards.
16) IS: 2720 (Part 7), 1980. Determination of water content-dry density relation using light compaction, Bureau of Indian standards.
17) IS: 2720 (Part 8), 1983. Determination of water content-dry density relation using heavy compaction, Bureau of Indian standards.
18) IS: 2720 (Part 40), 1977. Determination of free swell index, Bureau of Indian standards.
19) IS: 2720 (Part 16), 1987. Laboratory determination of CBR, Bureau of Indian standards.