



Geo-Technical Enhancement Of Expansive Soil Through Industrial And Plastic Waste Utilization.

¹Mr.Rushikesh P. Ambi, ²Ms.Ancika B. Singh.

¹Civil Engineering Department, Maharashtra, India

¹PADMABHOOSHAN VASANTDADA PATIL INSTITUTE OF TECHNOLOGY (PVPIT), PUNE

Abstract: Black cotton soil in India is another name for expansive soil. It tends to change its volume a lot because it takes in a lot of water and shrinks when it dries. This constant swelling and shrinking puts stress on structures, which can lead to damage like cracks in floors, foundations, and basement walls. The main problems with expansive soil are that it doesn't hold weight well, it compresses easily, it swells and puts pressure on things, and it shrinks. Studies have shown that using plastic and industrial waste materials is a good way to make expansive soil more stable. Adding materials like sawdust, rice husk, sugarcane bagasse, waste tires, incineration ash, fly ash, ceramic dust, glass fiber, broken bricks, agricultural waste, sawdust ash, and lime to the soil can make it better for geotechnical purposes. These improvements include a better maximum dry density, an optimal moisture content, a plastic limit, a liquid limit, a shear strength, a specific gravity, a swelling potential, and a California Bearing Ratio. Standard geotechnical tests like the Standard Proctor test, the Atterberg limits test, the specific gravity test, the unconfined compressive strength test, the California Bearing Ratio test, and the free swell test are used to measure these properties. This review paper is about figuring out the best amount of waste materials to use to make expansive soil better.

I. INTRODUCTION

When water is added to expansive soil, it gets bigger, and when it dries out, it gets smaller. When this soil gets wet, its volume changes a lot. Maharashtra, Karnataka, Andhra, and Gujarat are some of the biggest areas in India where expansive soil can be found. Rain, changes in temperature, bad drainage, and leaks in water systems are all natural causes of changes in soil moisture. Adding water to expansive soil makes it expand and then shrink when the water dries out. This makes the ground wetter, which is bad for things like houses, buildings, roads, and pipelines. When this soil gets wet, it changes a lot in volume. Montmorillonite minerals are found in expansive soil. These minerals soak up water easily. Because of this, people use a lot of different ways to stabilize soil to make it better. Strength, swelling potential, compressibility, and durability are the most important things that need to be improved. A lot of research looks at how to stabilize black cotton soil with plastic and industrial waste. Atterberg limits, unconfined compressive strength, shear strength, swelling potential, maximum dry density, optimum moisture content, and bearing capacity are all examples of soil properties that were tested in these studies. These properties are tested in natural soil and after mixing it with different amounts of trash. Recycling plastic waste helps keep plastic from taking up too much space in landfills. Cutting down on plastic is important for protecting the environment and saving resources. Recycling only 9% of plastic waste isn't enough to fix the plastic problem. Using plastic waste to stabilize soil is a cheap and good for the environment way to do it. It makes the soil better by increasing its shear strength, density, and bearing capacity. Recycling industrial waste cuts down on the amount of waste that is made and pollution. Industrial trash includes broken bricks, sawdust, rice husks, sugarcane bagasse, waste tires, incineration ash, fly ash, ceramic dust, glass fiber, agricultural waste, sawdust ash, and lime.

II. LITERATURE REVIEW

The research on the stabilization of expansive soil utilizing plastic and industrial waste has been conducted experimentally by different researchers in an analytical way.

S. Almuaythir et al. (2024)1: This experimental study investigates the use of various industrial waste material such as silica flume, cement kiln dust, calcium carbide residue, rice huck ash, ground granulated blast finance slab (GGBS) to stabilize the expansive soil. The mixing proportions of waste is as 3%, 6%, 9% of GGBS. Unconfined compressive strength value increases from 114.64 Kpa to 1582.91 Kpa after 30 days of curing. liquid limit reduces up to 37.66%. At 9% of GGBS value of shear strength increases. Finding suggest that industrial waste material is effective and sustainable alternative for soil stabilization.

D.T. Melese et al. (2024)2: Expansive soil is the soil which expand when water is added and shrink when water is dry out due to change in moisture content. The municipal solid waste fly ash is used as stabilizer to improve index properties of expansive soil. The percentage of fly ash added in soil to get optimum content of fly ash was 5%, 10%, 15%, 20%, 25%, 30%. The experimental analysis shows improvement in engineering properties of expansive soil when municipal solid waste fly ash is mixed. The optimum content of fly ash was 25% which gives optimum results.

S. Ahmad et al. (2024)3: Expansive soil exhibits drastic volumetric and compressibility changes due to moisture variation. This research highlighted the Behavior of expansive soil when treated with industrial waste pozzolanic fly ash. As fly ash is the residue left after the burning of coal in power plant which is considered as a solid waste. This paper reviews on the efficiency of fly ash as soil stabilizer in enhancing the mechanical behavior of expansive soil. The geotechnical properties determined in this study was Atterberg's limit, Unconfined Compressive Strength, California Bearing Ratio, Swell potential to investigate the behavior of soil with varying proportion of soil. The optimum content of fly ash was found to be between 25-40% at which there is improvement in plastic behavior up to 32%, compressive shear strength 42-48%, penetration resistance 52-55%, and compressibility 36- 40%. So, study has proven that fly ash is effective in soil stabilization.

Manish Kumar Mishra & Prof. Mohit Varma (2023) 4: This study highlights the use of polyethylene waste material to stabilize the expansive soil on respect to increase the Geotechnical properties of the soil. The orientation of study was mainly focuses on the parameter unconfined compressive strength of soil by adding plastic waste. Generally plastic bottles as a soil stabilizer in the proportion of 0.5-1% of the soil, with the addition of 0.5-1% of plastic the UCS gradually increases as follows: Table 1. Results of UCS with varying proportion of plastic waste.

Sr No	Plastic Waste %	UCS (kg/cm ²)
1	0.0	11.08
2	0.5	13.12
3	1.0	15.17

O Bhojaraj, R Prasad (2023) 5: This paper aims to identify the use of industrial waste such as steel skin, broken bricks, coir waste rice husk ash, ground nut shell ash and lime as a soil stabilizer. These wastes help to improve the shear strength of the soil along with bearing capacity. It also helps to provide more stability in case of slopes or other similar places. From the experimental analysis out of five samples four samples get CBR value less than 20% as per IRC 37-2001. hence these four samples can be used without any additives.

Kamble et al. (2022) 6: The study examined the stabilization of expansive soil (Black Cotton Soil) with the help of plastic waste i.e. plastic bottle strips. This process is carried out to improve the engineering properties of the soil and make it more stable. The study focuses on the reduction of unqualified characteristics of soil such as consolidation potential and permeability and to increase the shear strength with plastic waste by providing alternative solution as plastic recycling. The cold drink bottles are collected and cut down into the soil with different proportion as 0%, 0.2%, 0.4% and 0.6% of dry weight of soil samples are free swell index,

liquid limit, plastic limit, and specific gravity of soil. The paper concludes that this method is appropriate for sustainable foundation and improvement of soil by plastic bottles.

Mantu Kumar et al. (2022) 7: This Paper conclude that the black cotton soil used has plastic index 35%, Shrinkage index 39.2% and free swell index as 49.8% hence, the soil taken may be categorized as the expansive soil with high degree of expansion. the sample soil was reinforced with waste plastic bag strips of size 1 cm x 3 cm, 2 cm x 3 cm, 3 cm x 3 cm were added in soil at the rate in percentage to the weight of soil as 0.1, 0.4, 0.7 and 1. The results highlight the influence of plastic strips by improving Compaction characteristics, California bearing ratio and Shear strength of black cotton soil.

Niyomukiza, Wardani and Setiadji (2021) 8: This examination has analyzed the most recent trends in the stabilization of expansive soils through the utilization of waste materials, specifically focusing on waste tires, sawdust, sawdust ash, and fly ash as stabilizing agents. The identified waste materials have been shown to enhance the index properties, compaction characteristics, strength, and compressibility of expansive soils. Furthermore, employing these waste materials as stabilizing agents could potentially decrease the volume of waste disposed of in the environment or sent to landfills, thereby alleviating health and environmental issues associated with improper waste disposal. The optimal content of these waste materials for soil stabilization is contingent upon the specific properties of the soil in question. Consequently, it is advisable to prioritize the practical application of these waste materials in the field rather than solely concentrating on laboratory studies. Several research gaps have been identified, including the need for further investigation into the microstructural characteristics of soils stabilized with waste materials. The use of shredded waste tires helps to improve the load carrying capacity and reduce plastic limit of the soil with optimum waste tire of 20 % by weight. The paper stated that more studies are needed to know the exact size and optimum content of the waste tire used to stabilized the soil. The saw dust is used in the proportion of 3 % of weight of the soil which is found to be effective in increasing Unconfined Compressive Strength (UCS).

Garg et al. (2021) 9: They studied that addition of Sugarcane bagasse ash (SBA), Ceramic dust (CD) and Glass fiber into the black cotton Soil has changed the maximum dry density swelling of soil, optimum dry density, swelling of soil optimal moisture content, California bearing ratio (CBR) and Unconfined compressive strength (UCS). The study was carried out by the varying content in percentage of SBA (0-20), GF (0-4) and CD (0-20) in Expansive soil. At the content of SBA -15, CD- 10 and GF- 3 the soil mobility is observed low and controlling swell behavior. the addition of 1-3 Glass fiber was result in reduction of liquid limit and the CBR value increase in the content of Sugarcane bagasse ash (15), Ceramic dust (0-15).

R. B. Kassa et al. (2020) 10: The study highlights the use of Waste plastic material as a soil stabilizing agent. the plastic strips were prepared in there different mixing rates (5 mm *7.5 mm, 10 mm *15 mm, 15 mm *20 mm) and added at three different mixing ratios (0.5%,1% and 2%) by weight. the result shows improvement in shear strength parameters, reduction in swelling and optimum moisture content, increase in maximum dry density. The optimum moisture content decreases at a strip size 5 x 7.5 mm with 2% addition by 31%, 30% deduction in swell observe at strip size 5 x 7.5 mm with 2% addition. The shear strength increases from 49.83 Kpa to 62.67 Kpa which is 26% improvement at the same strip size also, at strip size 5 x 7.5 mm with 2% addition the Unconfined strength obtained is 307.4 KN which is for natural soil is 151.8 KN.

III. CONCLUSION

From the above discussion, one can conclude that several experiments have been carried out on soil stabilization using different kinds of industrial and plastic waste. This not only reduces the effect of stabilization but also helps to improve geotechnical properties of expansive soils. The optimum amount of various wastes found was 2% strip size being 5 mm x 7.5 mm, where optimum moisture content decreased by 31%, shear strength increased by 26%. In case of shredded waste tires optimum value was found to be 20%, which enhances the soil bearing capacity. The sawdust content was 3% which aids in increasing Unconfined Compressive Strength and reducing Swelling Potential. Fly ash content was around 25-30%. It improves the characteristics of soil. Other wastes like rice husk, sugarcane bagasse, incineration ash, ceramic dust, glass fiber, crushed bricks, agricultural waste, sawdust ash, and lime also improve the geotechnical characteristics of soil like Specific Gravity, Maximum Dry Density, Atterberg's Limit, California Bearing Ratio. Thus, it gives a solution to the problem of waste management as well as an economical process of soil stabilization.

REFERENCES

- [1] Almuaythir, S., Zaini, M. S. I., Hasan, M., & Hoque, M. I. (2024). Sustainable soil stabilization using industrial waste ash: Enhancing expansive clay properties. *Heliyon*, 10(20).
- [2] Melese, D. T., Jida, G., Beyene, R., Woldesenbet, T. T., Meshesha, A. E., & Geleta, W. S. (2024). Expansive clay subgrade soil improvement using municipal solid waste fly ash: Experimental and numerical approach. *Environmental Challenges*, 16, 100998.
- [3] Ahmad, S., Ghazi, M. S. A., Syed, M., & Al- Osta, M. A. (2024). Utilization of fly ash with and without secondary additives for stabilizing expansive soils: A review. *Results in Engineering*, 102079.
- [4] Manish Kumar Mishra and Prof. Mohit Verma: Study and Analysis of Soil Stabilization with Polyethylene Waste Materials:
International Journal of Research Publication and Reviews, Vol 4, no 12, pp 2969-2974 December 2023.
- [5] O. Bhojaraj and R. Prasad: Stabilization of Expansive Soil Using Various Industrial Waste Materials
Source: *International Journal of Research Publication and Reviews*, Vol. 4, No. 3, pp. 1614-1617: March 2023.
- [6] Kamble, U., Deshmukh, P., Thak, P., Ther, J., & Shaha, J. (2022). Soil stabilization by using plastic waste. *Int. J. of Aquatic Science*, 13(1), 157-161.
- [7] Kumar, M., Azhar, M., Mondal, S., & Singh, RP (2022). Stabilization of expansive soil subgrade by waste plastic. *Arabian Journal of Geosciences*, 15 (10), 936.
- [8] B H Setiadji, J B Niyomukiza, S P R Wardani: Recent advances in the stabilization of expansive soils using waste materials:
A review, *IOP Conf. Series: Earth*
- [9] Aniket Kumar, Rishav Garg, Tinku Biswas, MD Danish Alam, Anubhav Siddharth, Divanshu Raj Singh: Stabilization of expansive soil by using industrial waste: *Journal of Physics: Conference Series ICAPSM 2021*.
- [10] Kassa, R. B., Workie, T., Abdela, A., Fekade, M., Saleh, M., & Dejene, Y. (2020). Soil stabilization using waste plastic materials. *Open Journal of Civil Engineering*, 10(1), 55-68