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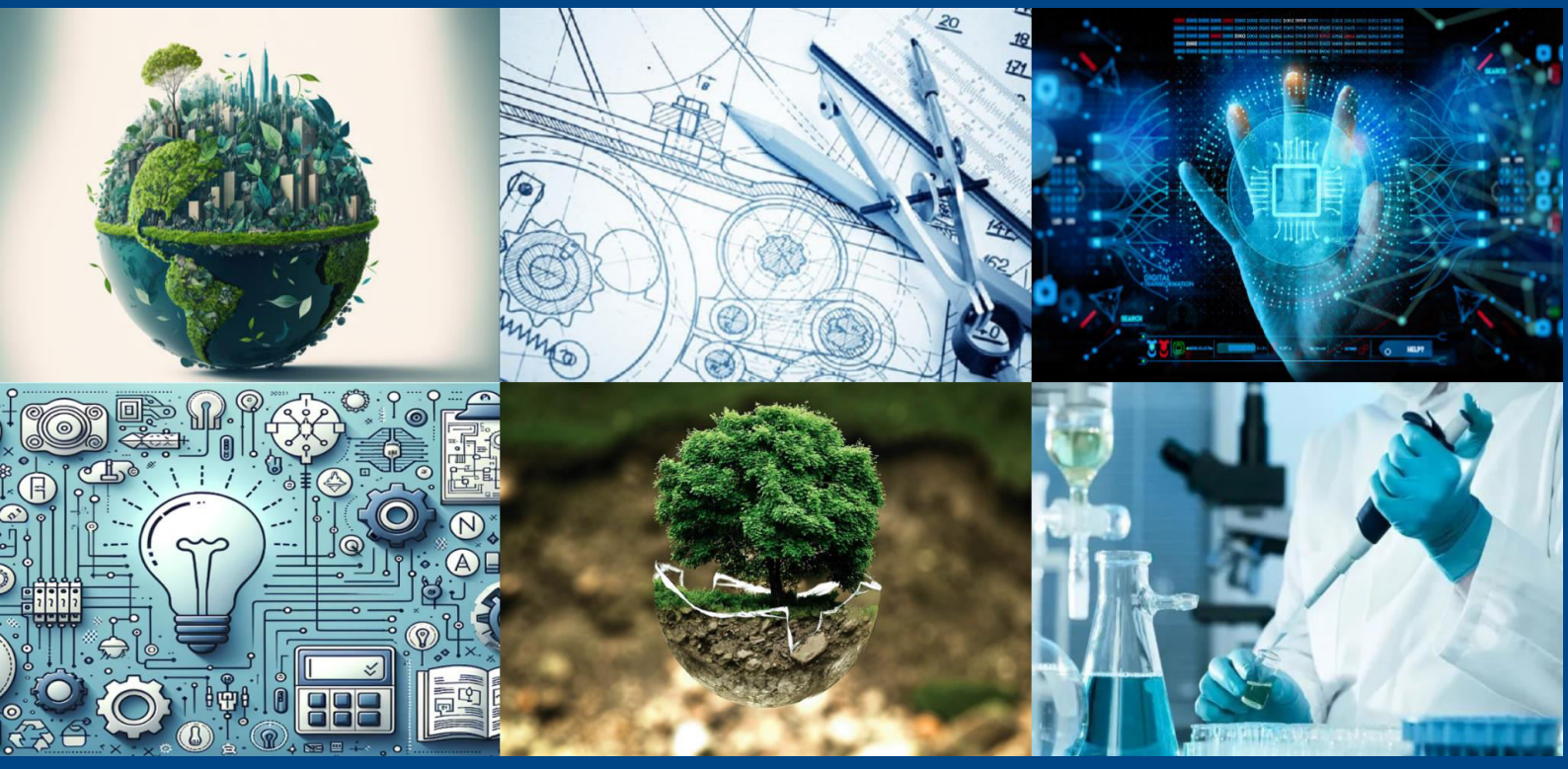

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Soil Stabilization using Waste Plastic Material

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ABSTRACT: Soil stabilization is a crucial process that enhances the physical properties of soil, such as shear strength and bearing capacity, making it suitable for construction purposes. Traditional stabilizers like cement, lime, and fly ash are effective but costly and environmentally unfriendly. This project explores the use of waste bottle plastic as an alternative soil stabilizer. By incorporating plastic waste into soil, we aim to improve its engineering properties while addressing the growing problem of plastic waste disposal. Preliminary tests indicate that adding plastic strips from waste bottles significantly increases the soil's shear strength and California Bearing Ratio (CBR) values. This eco-friendly approach not only reduces environmental pollution but also offers a cost-effective solution for soil stabilization. The project's findings suggest that waste bottle plastic can be a viable and sustainable alternative to conventional stabilizers, contributing to both environmental conservation and infrastructure development.

KEYWORDS: Soil Stabilization, Eco-friendly, Cost-effective Solution, Environmental Pollution, Sustainable Alternative, Infrastructure Development

I. INTRODUCTION

Black cotton soil, commonly found in many regions, is known for its poor load-bearing capacity and susceptibility to shrinkage and swelling when exposed to moisture changes. These properties make it challenging for construction, especially in areas that require stable foundations. With increasing construction and infrastructure projects, it is vital to find ways to stabilize and improve the strength of this soil. The solution proposed in this project is to use waste plastic, specifically plastic bottle chips, as a stabilizer for black cotton soil. By incorporating waste plastic into the soil, we aim to reduce environmental pollution, enhance soil strength, and make it more suitable for construction purposes. This innovative approach not only addresses the growing issue of plastic waste but also presents a cost-effective and eco-friendly method to improve the quality of construction in areas with black cotton soil.

Current Trends in Plastic Waste

Plastic waste has become a major environmental issue globally, with millions of tons generated every year. Items like plastic bottles, packaging, and bags are non-biodegradable and take hundreds of years to decompose. As plastic waste accumulates, it poses severe environmental risks, contaminating landfills, water bodies, and ecosystems. This has prompted a growing interest in finding innovative ways to recycle and reuse plastic materials to reduce their environmental impact.

In the construction sector, plastic waste is increasingly being explored as a potential solution to address issues like unstable soils, particularly expansive soils such as black cotton soil. These soils often suffer from low load-bearing capacity, shrinkage, and swelling, making them difficult to work with in construction. To combat this, researchers have turned to incorporating waste plastic, such as plastic bottles, into soil stabilization methods. By adding plastic waste to soil, studies have shown improvements in soil strength, reduced shrinkage, and better load-bearing capacity.

The use of plastic waste as a soil stabilizer not only helps mitigate environmental problems but also provides an affordable and sustainable alternative to traditional stabilizers like cement. This method has gained attention due to its potential to enhance soil properties and make construction more cost-effective. By reusing plastic waste, we not only reduce pollution but also contribute to more sustainable building practices.

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As research into plastic waste in soil stabilization continues to evolve, it is expected that more construction projects will adopt these eco-friendly solutions. Governments and industries are increasingly supporting these innovations, paving the way for a greener and more sustainable future in construction.

II.LITERATURE REVIEW

Achmad Fauzi et. al,(2016) have worked on **"Soil engineering properties improvement by utilization of cut waste plastic and crushed waste glass as additive"[1].** According to them, In general, clayey soil was used as soil material or embankment material for increasing road way level before road structure being constructed. Some types of clay are expansive soil, its have been contributing to pavement failures and subsequently causing increased annual maintenance expenditure of the road. The pavements design/redesign methods are found to be the primary cause of these failures. Thus, it is quite important to propose the utilization of waste plastic and waste glass on soil subgrade improvement and then contributing decreased of pavement failures. This paper was evaluated the engineering properties on utilizing waste plastic High Density Polyethylene (HDPE) and waste crushed glass as additive on subgrade improvement. The research were conducted soil engineering properties, standard compaction, four days soaked California Bearing Ratio (CBR) and Triaxial test to some clayey soil samples from various sites in Kuantan. The 4 days soaked CBR of clayey soil samples were prepared at optimum water content. The variation of additive content on stabilized soil: 4%, 8%, 12% by dry total weight of soil sample respectively. The chemical element was investigated by Integrated Electron Microscope and Energy-Dispersive X-Ray Spectroscopy (SEM-EDS). Test result were shown that engineering properties and CBR on stabilized clayey samples were increased when the content of waste HDPE and Glass were increased.

Chebet et. al,((2014) have worked on **"laboratory investigation on re-using polyethen (Plastic) bag, waste material for soil reinforce-ment in geotechnical engineering"[2].** According to them,This paper presents a laboratory investigation into the resultant increase in shear strength and bearing capacity of locally sourced sand due to random inclusion of strips of high density polyethylene material from plastic shopping bags. A series of direct shear tests and bench-scape plate loading tests was undertaken on soil-plastic composites of two selected sandy soils: Klipheuwel and Cape Flats sands. Strips of shredded plastic material were used as reinforcement inclusions at concentrations of up to 0.3% by weight. The effect of varying dimensions of the strips was investigated by using strip lengths from 15 mm to 45 mm and strip widths from 6 mm to 18 mm. Soil strength parameters were obtained for composite specimen from which analyses were carried out to identify the extent of soil improvement. Laboratory results obtained favourably suggest that inclusion of this material in sandy soils would be effective for soil reinforcement in geotechnical engineering.

Dr. A.I Dhatrak et. al, ((2015) have worked on **"performance of randomly oriented plastic waste in flexible pavement "[3].** According to them, Plastic waste problem is now become very critical issue in aspect of decomposition, which is a challenge to environmental control system. Now plastic is not used for particular use, it becomes addiction in daily life of human being as well as in industry. Huge quantity of plastic waste is found in MSW i.e. drinking bottle, carry bags, packing paper etc. This plastic can be effectively used for improving the performance of flexible pavement, also solve the problem of disposal of plastic waste. The aim of project is to improve engineering properties of soil by using Plastic waste strips/ chips. On the basis of various research paper studies, it is observed that the soil stabilization using waste plastic bottles chips is an alternative method for improvement of sub grade soil of pavement used for construction of flexible pavement. This paper is based on the experimental work study on use of plastic waste in soil used for construction of flexible pavement and an attempt is made to control plastic waste pollution for green Environment as Geo environment trend. Experimental work includes compaction and CBR behaviors of plastic strips reinforced in soil. Comparative study of plain soil and composite soil was also studied in present research work.

Gupta et. al, (2018) have worked on **"Behavior of soil by mixing of plastic strips" [4].** According to them,Digital Evidence Detection in Virtual Environment for Cloud Computing inACM, 2012 Authors at Hyderabad a technique for Cloud Computing domain and that was named Digital Evidence Detection technique. Some conventional methods were discussed in their works which were used as a tool for performing forensic observations and those methods were useful

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to learn and examine the behavior of the digital evidences in a virtualized environment called Cloud. Also the feasible solutions are shown in which forensic practices can be performed in virtual environment.

K Gopinath, K Anuratha (August 2015) have worked on **"Utilization of saw dust in cement motor and cement concrete" [5].** According to them, The use of sand (river sand) plays a major role in all type of construction, especially in cement concrete & cement mortar. The ultimate aim of the saw dust concrete is to recycle the waste material from saw mill & utilizing in concrete ingredients in the state of partial replacement. Sequentially, the shortage of river sand is partially rectified by the replacement of sawdust for the sand. So, the river sand abundantly gets destructed due to the huge consumption. To enhance the progress of river sand, we prefer a scope on saw dust concrete. In this project, we introduce two reproductive form of sawdust, and we named as Dry Sawdust (DSD) and Sawdust Ash (SDA). Dry sawdust was used partially replacement for fine aggregate and Sawdust Ash was used for partially replacement for cement. Dry Sawdust & Sawdust Ash were mixed with concrete separately, in this study, totally 16 mortar cubes & 48 concrete cubes are casted. And these are subjected to test, such as Slump test & Compressive test, then it is compared with normal mix of concrete & mortar. The application of saw dust mix for residential building structural member such as column, beam, slab and foundation and plastering are also elicited. The study brings out the fact that it also more economical than the typical cement concrete.

Rajkumar Nagle et. al, ((2014) have worked on **"comparative study of CBR of soil, reinforced with natural waste plastic material".** According to them, Infrastructure is a major sector that propels overall development of Indian economy. The foundation is very important for any structure and it has to be strong enough to support the entire structure. For foundation to be strong the soil around it plays a very important role. Expansive soils like black cotton soil always create problems in foundation. The problems are swelling, shrinkage and unequal settlement. Plastic wastes have become one of the major problems of the world. Use of plastic bags, bottles and other plastic products is exponentially increasing year by year. Due to which we are facing various environmental problems. A review paper is presented here to focus on soil stabilization by using waste plastic products. The tests such as liquid limit, plastic limit, standard proctor compaction test, California bearing ratio (CBR) test and unconfined compressive strength (UCS) have been conducted to check the improvement in the properties of black cotton soil.

Sachin tiwari et. al, have worked on **"Stabilization of soil with waste plastic bottles".** According to them**,** some soils cannot withstand heavy loads due to significantly low California Bearing Ratio and shear strength. So, to reduce this problem treatment of soil is needed to be done using different stabilizers like furnace slag, fly ash, either providing physical or chemical treatments and by blending and mixing of some other materials with the soil. It helps in controlling the shrink-swell properties of soil and also improves the shear strength properties and the capacity of soil to support the loads. This paper is aimed at providing soil stabilization using the waste plastic. The main motive of this research is to evaluate the result of incorporating waste plastic bottles on the geotechnical properties of soil. Various percentages of waste plastic bottles (0%, 0.5%, 1.0%, 1.5% and 2.0%) added in the soil sample and sequel the engineering properties of soil. For this, various laboratory tests were conducted on soil samples like Unconfined Compressive Strength, California Bearing Ratio, and Proctor Test etc. and compared with the soil samples without any plastic waste. The outcome of the study showed that addition of the waste plastic bottles have positive effect on the soil properties which promotes the re-use limestone fines, bitumen, plastic waste etc. It is defined as the process for improving the properties of the soil of waste plastic from industry in an economical and environmentally friendly way and it will also help with the disposal problem of these plastic wastes on some extend.

Table 1:

No.	Paper Title	Author Name	Key Points	Remark
1	Soil engineering properties improvement by utilization of cut waste plastic and crushed waste glass as additive	Achmad Fauzi et al(2016)	The content of the additives (HDPE and glass) used in the stabilized soil was varied at 4%, 8%, and 12% by dry weight of the soil sample. [1]	Achmad Fauzi et al. (2016) found that adding waste plastic (HDPE) and crushed glass improves the strength of clayey soils, enhancing their stability for road construction. Higher additive content

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				showed better results in soil reinforcement.
2	laboratory investigation on re-using polyethen (Plastic) bag, waste material for soil reinforce-ment in geotechnical engineering	Chebet et al (2014)	1. Shredded plastic from shopping bags was used to reinforce sandy soils. 2. The plastic was added at concentrations of up to 0.3% by weight. 3. Tests showed an increase in shear strength and bearing capacity. 4. The plastic reinforcement proved effective for soil improvement in geotechnical engineering. [2].	Chebet et al. (2014) found that adding shredded plastic from shopping bags into sandy soils improved their strength and bearing capacity. Even small amounts (0.3% by weight) were effective for soil reinforcement.
3	Performance of randomlyoriented plastic waste in flexible pavement	Dr. A.I Dhatrak et al (2015)	1. Plastic waste is a growing environmental issue, particularly in MSW. 2. Plastic strips/chips are used to improve the engineering properties of soil for flexible pavement construction. 3. The study focuses on compaction and CBR behavior of plastic-reinforced soil. 4. A comparison between plain soil and composite soil was made to assess improvements. [3]	The use of plastic waste in flexible pavement construction improves soil stability while also addressing the environmental problem of plastic waste disposal.
4	Behavior ofsoil by mixing of plastic strips	Gupta et al. (2018)	1. The study focuses on improving the behavior of soil by mixing plastic strips. 2. The use of plastic strips helps in enhancing the strength and stability of the soil. 3. The experimental work aims to explore the impact of plastic strips on soil's engineering properties. [4].	Gupta et al.'s study presents an innovative method of stabilizing soil by incorporating plastic strips, which enhances the soil's strength and can be a sustainable solution to improve construction materials.
5	Utilization of saw dust in cement motor and cement concrete	K Gopinath, K Anuratha (August 2015)	1. Sawdust is used as a partial replacement for river sand and cement in concrete and mortar. 2. The aim is to recycle sawmill waste and reduce the environmental impact of river sand extraction. 2. Two forms of sawdust were used: Dry Sawdust (DSD) as a substitute for fine aggregate and Sawdust Ash (SDA) as a partial substitute for cement. 3. The study involved casting 16 mortar cubes and 48 concrete cubes for testing. - Tests included Slump and Compressive Strength tests to compare the properties of sawdust concrete	This study by Gopinath and Anuratha offers a sustainable and cost-effective solution to the growing shortage of river sand, by using sawdust and sawdust ash in concrete and mortar. The results indicate potential for wider application in construction, while also promoting recycling of industrial waste materials.

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			with traditional concrete. 4. Sawdust concrete was found to be more economical and can be used in residential building construction (e.g., columns, beams, slabs, and plastering). [5].	
6	Comparative study of CBR of soil, reinforced with natural waste plastic material	Rajkumar Nagle et al (2014)	1. Soil Strength Issues: Expansive soils, such as black cotton soil, cause problems in construction foundations due to swelling, shrinkage, and uneven settlement. 2. Plastic Waste: The rapid increase in plastic waste poses environmental challenges. 3. Soil Stabilization: Using waste plastic products to stabilize black cotton soil offers a potential solution. 4. Testing: Liquid limit, plastic limit, Proctor compaction, CBR, and UCS tests were conducted to analyze the improvement in soil properties. 5. Environmental Benefit: This method helps in reducing plastic waste and improving soil properties for construction purposes.	The study highlights an innovative approach to improving black cotton soil's properties using waste plastic, which not only strengthens foundations but also addresses environmental concerns related to plastic waste disposal.
7	Stabilization of soil with waste plastic bottles	Sachin tiwari	1. Soil stabilization improves properties like shear strength and load-bearing capacity. 2. Waste plastic bottles were incorporated in varying percentages (0%, 0.5%, 1.0%, 1.5%, and 2.0%). 3. Laboratory tests like Unconfined Compressive Strength, California Bearing Ratio, and Proctor Test were conducted. 4. Results showed improvement in soil properties with the addition of waste plastic bottles. 5. The research promotes the reuse of plastic waste in an eco-friendly and cost-effective manner.	This study successfully demonstrates that waste plastic bottles can enhance soil stability, making it a viable, sustainable solution for both soil improvement and plastic waste disposal.

III. METHODOLOGY

1. Literature Review

Conduct a comprehensive review of previous studies and research papers that focus on the stabilization of black cotton soil using waste plastic chips. This review will help us understand the different methods and approaches that have been used in past studies to improve the properties of black cotton soil through the inclusion of plastic waste. By analyzing the findings from these studies, we will identify areas where the existing methods can be enhanced, such as determining the optimal proportion of plastic chips to mix with black cotton soil, the best techniques for blending, and the impact of this treatment on the soil's strength, permeability, and stability. Additionally, this literature review will help us assess

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the environmental and economic benefits of using waste plastic in soil stabilization and how it compares to traditional stabilization methods like lime or cement.

2. Collection of Materials

The black cotton soil for this project was collected from a local farm in Abdullat, Shirol, which is situated near a river. The proximity to the river influences the soil's properties, including its texture and moisture content.

The black cotton soil from this farm is known to have low strength, making it suitable for testing in construction-related projects, where soil stability is a critical factor.

For the plastic chips, we gathered used plastic bottles, cleaned them thoroughly to remove any impurities, and then cut them into small chips of uniform size.

These plastic chips were then mixed with the black cotton soil to evaluate how they affect the soil's strength and stability.

3. Laboratory Testing

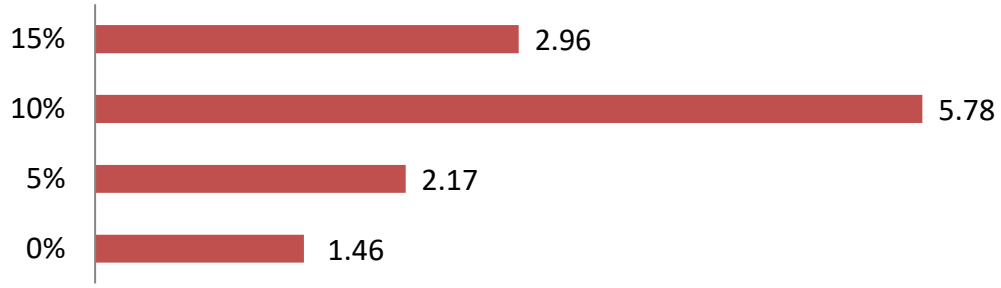
We checked the basic properties of black cotton soil to understand its characteristics. Then, we mixed different amounts of plastic chips (5%, 10%, and 15% of the soil's weight) into the soil to test how these additions affected the soil's strength and stability.

To measure the changes, we used the Vane Shear Test and the California Bearing Ratio (CBR) Test. Our results showed that the addition of 10% plastic chips provided the best improvement in soil strength and stability for both tests.

Vane shear test:

Sr. no.	% mix with soil	initial angle of twist	final angle of twist	Torque in Nmm	Shear stress in N/mm2
1	0%	0	20	69.81	0.00045
2	5%	0	10	34.91	0.00867
3	10%	0	31	108.21	0.026
4	15%	0	5	17.45	0.0043

CBR Test



Shear strength
Load : 1.4Kg

IV. CONCLUSION AND FUTURE WORK

The use of plastic bottle chips for stabilizing black cotton soil has shown significant improvements in soil strength. Our results showed that the addition of 10% plastic chips provided the best improvement in soil strength and stability for both tests. Reduced swelling and shrinkage, and increased durability. This eco-friendly and cost-effective solution not only enhances the soil's properties, making it ideal for roads, embankments, and building foundations, but also helps

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reduce plastic waste, contributing to environmental sustainability. Looking ahead, future research can focus on optimizing the plastic chip content for different soil types and environmental conditions, as well as examining the long-term performance of plastic-treated soil in various construction applications. Scaling this method for large-scale infrastructure projects could further promote sustainable construction practices and provide a greener solution to construction challenges.

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