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An overview on use of waste plastic for soil stabilization

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ABSTRACT. *There have been various environmental concerns recently as a result of the huge increase in the use of plastic products like polypropylene (PP) and polyethylene (PE) bottles. Therefore, it's critical to develop strategies for managing these wastes without endangering the environment. Utilizing waste plastic as soil stabilizer materials is one of these techniques. Waste plastic, after some treatment or recycling, has been reported to be used in different forms as construction materials. However, its use for soil stabilization has not exclusively been reported. Thus, the goal of the current literature research is to have a comprehensive review of the literature about the potential of waste plastic for soil stabilization. This is done by focusing on articles published in highly reputable journals in the last decade. The major benefit, however, is that it is incredibly cost-effective because it has demonstrated a significant improvement in soil qualities. It offers a good stabilization approach as opposed to more expensive alternatives. Waste Plastic production is steadily increasing, which has resulted in several poor disposal techniques, such as burning, and a variety of environmental and pollution issues. As a result, finding secure and effective disposal techniques is essential for protecting our environment and the future of the following generations.*

Keywords: Waste plastic management, applications, and recycling.

1. INTRODUCTION

Industry standards in public health, business, engineering, preservation, design, and other fields associated with the environment factors, the control of the production, preservation, gathering, transport and distribution, processing and preparation, and disposal of wastes is referred to as solid waste management [1]. Waste is anything (such as plastic, food, or paper) that is disregarded because it will not serve its original purpose and will not be useful or valuable to the owner. According to [2], trash is divided into the following categories: State of being (As an example, consider solids, liquids, and gases (like agriculture, mining, quarrying, manufacturing, industrial, construction, household, commercial, etc.), biological traits (combustible, compostable, and recyclable), Safety level (including such hazardous and non-hazardous) and specific material (like plastic, glass, metal, paper, food, etc.)

In numerous geotechnical infrastructure applications, including road bases, landfill plots, and slope stabilization, Studies have been conducted into the usage of polyethylene recyclable plastic bags for strengthening soil. Reduced soil displacement, lateral stability, shear and tensile strength, and strength characteristics, increased liquefaction resistance, and durability of weak soil can all be improved by combining plastic garbage with the earth. Solid waste is any waste that does not include liquid or gas. The combined municipal substantial trash is made up of commercial and domestic solid garbage (MSW). Plastics, organic materials, metals, papers, and glass are all parts of MSW. Considering that MSW is frequently combined, disposal is challenging to handle. Solid waste management is the practice of safely disposing of MSW through landfill, incineration, and recycling to prevent harming both the environment and people. The concern is given to managing plastic garbage in this chapter's part [1].

In order to create an improved soil material with all the required engineering characteristics, the soil system is able to modify some soil properties utilising a wide range of chemical or mechanical processes. Typically, soils are stabilised to increase their strength and resilience or to halt land degradation. The success of ground improvement depends on soil testing because soil parameters vary widely from place to place, and in a few cases even from one

site to another. There are multiple methodologies for stabilising soil, but before utilising one in a field, each should be tested in a lab with actual soil.

To the best of the authors' knowledge, soil stabilization using waste plastic in different forms is rarely reported. This review paper aims to explore the potential of waste plastic for soil stabilization as reported in the literature. For this purpose, articles published in highly reputable journals in the last decade are reviewed in detail to gather all published information related to waste plastic used in soil stabilization. First, waste plastic applications are discussed. Then, recycling and management of waste plastic are reviewed. Finally, soil stabilization using waste plastic is explored.

2. WASTE PLASTIC APPLICATIONS

Applications of different types of plastic are: Polyethylene terephplastthalate, one of the most commonly used thermoplastic polymer resins, is known as "plastic number 1." As PETE or PET plastic, it is well-known. One of the healthiest plastic types is Plastic 2. It is also known as HDPE (high-density polyethylene) and has exceptional wear resistance because of its high strength-to-density ratio. Plastic 3 won't be one of the greatest recycling codes. Polyvinyl chloride, also known as PVC, is one of the least recyclable plastics and is extremely dangerous. Even though, PET plastic is just as common as plastic number 3. One of the first types of polyethylene is Plastic 4, often known as LDPE (Low-Density Polyethylene), which is plastic. Although LDPE 4 is thought to be fairly safe to use, just a small portion of LDPE 4 plastic can be recycled, making it not very eco-friendly. The next most often produced plastic is plastic number 5, sometimes known as polypropylene or PP plastic. PP is utilized in a variety of packaging because it is lightweight, resistant to heat, and durable. Polystyrene, sometimes known as polystyrene (PS), is the sixth plastic. This is among the plastic recycling codes that need to be avoided or, at least, reused as it is hard to recycle 6 plastics. Essentially, Plastic 7 refers to anything else not covered by the previous plastic recycling rules. It includes bioplastics, brand-new plastics, etc.

Table 1: Plastic Types and their Applications [5]

Numbers	Plastic type	Applications
1	Polyethylene Terephthalate (PET)	PET is a clean, robust, and lightweight plastic that is significantly used in the packaging of ingredients and beverages, particularly comfort-sized tender beverages, juices, and water.
2	Polyvinyl Chloride (PVC)	PVC is utilized in a spread of packages, together with window frames, drainage pipes, water carrier pipes, clinical gadgets, blood garage luggage, cable and twine insulation, durable floors, roofing membranes, stationery, automobile interiors, and seat covers.
3	High Density Polyethylene (HDPE)	HDPE (High-Density Poly Ethylene) is a thermoplastic polymer crafted from petroleum. Plastic bottles, milk jugs, shampoo bottles, bleach bottles, cutting forums, and pipes are only a few of the packages for HDPE plastic.
4	Low Density Polyethylene (LDPE)	Bins, meting out bottles, wash bottles, tubing, plastic baggage for pc additives, and unique molded laboratory gadget are a number of the maximum common uses for Low-Density Polyethylene (LDPE). Plastic bags are the maximum not unusual utility for low-density polyethylene.
5	Polypropylene (PP)	Due to its low cost and versatility, PP has replaced conventional materials including paper, cellophane, and paper in a number of packaging formats. They are used to create a range of products, including food packaging, yoghurt containers, hot beverage cups, bottles, jars, and pallets.
6	Polystyrene (PS)	The solid, affordable plastic polystyrene (PS) is used to create a variety of products, such disposable plastic flatware and dinnerware, CD "jewel" cases, smoke detector housings, licence plate frames, and plastic model construction kits.
7	Others like Polyester, Polyimides etc.	Bottles, films, tarps, sails (Dacron), canoes, liquid crystal presentations, holograms, filters, dielectric film for capacitors, film insulation for cords, and insulating tapes are all made from polyesters. Polyamide can be found in a variety of textiles, including garments and carpets.

Waste management continues to be a problem in many parts of the world because of urbanization, population growth, and industrial expansion. The traditional techniques for getting rid of solid waste include recycling, incineration, and landfilling. The development of civil engineering infrastructure, such as highways, railroads, dams of various types, retaining walls, tunnels, embankments, and buildings, has been significantly influenced by urbanization and modernization. There is a significant demand for top-notch soil and other building materials. High-quality, naturally occurring soil is becoming scarce in some areas, and importing it from a distance would be costly and time-consuming. PET plastic is therefore the material of choice for soil stabilization. PET fibres are an economical and environmentally favourable option.

3. RECYCLING AND MANGEMENT OF WASTE PLASTIC

Plastic is recycled less regularly than other materials used in significant quantities including paper, ceramics, glass, and aluminium. The recycling process involves several different steps, including production, distribution, usage, disposal, and sorting. As a result, the entire procedure is seen to be complex. The recovery of waste plastic, though, can be done mechanically, chemically, or thermally. However, sorting first must take place before the plastic garbage can be recovered. This is largely done mechanically utilizing technology like electromagnetics, flotation, fluorescence, infrared, and spectroscopic [10]. The physical degradation of the waste through the use of methods like grinding and/or shredding is an essential process in the mechanical plastic recycling process. waste. The complex nature of mixtures of plastic garbage, however, is said to make mechanical recycling fairly inefficient, therefore the majority of plastic pollution is instead burned. However, it is pretty apparent from the research that the recycling process is still the favorite approach for recycling plastic. It is simple and quick to carry out [6,9].

Plastic wastes can be converted into monomers for chemical recycling or chemically altered to create new plastic products instead of using virgin raw materials. Waste plastic is heated to a high temperature to melt it, then is poured into a mold to create new items. This process is known as thermal recycling. High-density polyethylene (HDPE), polyethylene terephthalate (PET), polypropylene (PP), polystyrene (PS), and polyvinyl chloride (PVC) were all evaluated by [7] their recycling potential. According to the study, plastics' specific properties have an impact on their ability to be recycled. Fig. 1 compares the possibilities for recycling, reprocessing, and sorting different plastics. Plastics in this category have an above-average 50% sorting and reprocessing potential. However, PET has the lowest recycling potential of all plastic kinds. It can be concluded that PET might be more appropriate for other applications than recycling. By reducing the production of plastics and plastic products, outlawing unnecessary packing, removing litter, and recycling, we can lessen the environmental damage caused by waste plastic.

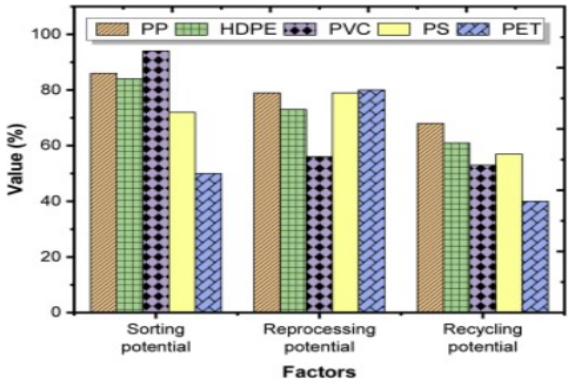

Fig-1: Comparison of sorting, reprocessing and recycling potentials of various plastics [8]

4. SOIL STABILIZATION USING WASTE PLASTIC

Plastic is employed in a variety of industries, including building, production, automotive, furnishing, sports, electrical and electronics, health & safety, consumer goods, and home appliances. In the realm of civil engineering, plastic is a material that is used to construct bridges, buildings, roads, highways, ports, railroads, landscaping, landfills, and water retaining structures. Some of the plastic components utilized in the construction sector include sound barriers, guide rails/guard rails, piling, foundations, railroad ties, pallets, speed bumps stop, docks, board walkways and pavements, cycling racks, foundation backfills, corrosion management, and building material separations [3]. To be deemed the ideal building material in civil engineering, a material must be robust, ductile, easy to use, fire resistant, and relatively inexpensive.

Additionally, building plastics have the following features are; plastics are durable and can resist being knocked over and scratched, plastics are durable and can survive weather extremes, Plastic is simple to set up and move, plastics allow for flexibility in design because they can be molded into any shape and available in a multitude of

colors, opaque or transparent finishes, rigid or flexible items, plastics help houses use less energy since they are poor heat exchangers and can provide a tight seal, plastic products require less upkeep and don't need painting and it is possible to reuse plastic building materials with little energy input and to turn the substance into energy and using plastic in constructions is economical since it is long-lasting, high-quality, and demands little maintenance [4]. Yet, if growing volumes of PET plastic waste greater than 32.5% are eliminated, the overall amount of plastic waste discharged in landfills will decrease.

5. CONCLUSIONS

This review paper explores the potential of waste plastic for soil stabilization as reported in articles published in highly reputable journals in the last decade. The current effort is to compose all published information related to waste plastic used in soil stabilization. Based on this literature research, the following are the conclusions:

- A cost-effective and environmentally friendly alternative is to add PET fibers.
- To reduce environmental pollution due to waste plastic by decreasing the manufacturing of plastics and plastic products, banning excessive wrapping, collecting litter, and recycling.
- The strength and engineering qualities of fiber-reinforced soil are improved. Yet, if growing volumes of PET plastic waste greater than 32.5% are eliminated, the overall amount of plastic waste discharged in landfills will decrease.

The recommendations may be useful in the fight against plastic pollution: In both public awareness and education, an alternative is bioplastics and proper Recycling and managing waste plastic, especially bottles.

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