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ORIGINAL ARTICLE

An Overview of Polyethylene Terephthalate (PET) as a Partial Cement Replacement in Soil Stabilization

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ABSTRACT - One of the most important components of nature is soil, which satisfies all of our fundamental needs for food, shelter, and clothing. One of the main soil deposits found all over the world is soft soil, which has a high expansion and contraction of capacity due to the changes in moisture content. Through the process of controlled compaction or by adding appropriate admixtures such as cement, lime, sand, and fly ash, soil stabilization enhances the physical characteristics of soil, such as its shear strength and bearing capacity. By reducing waste production and generating useful materials from non-useful wastes, innovative technology for soil stabilization can be used to tackle societal concerns. Since the usage of plastic in numerous forms, including bottles and polythene bags, has been expanding quickly and its disposal has been a problem consistently about environmental concerns, using plastic as a soil stabilizer would lessen the issue of disposing of the plastic and would also cost-effectively enhance the density of soil.

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INTRODUCTION

The most common building material in nature is soil. Pretty much every single type of construction depends on or is based on the soil. Due to the rapid increase in abandoned sites because of the low soil holding capacity, there was a shortage of land and an increase in demand for natural resources [1].

However, in the majority of geotechnical projects, it is impossible to secure a construction site that will meet the design criteria without ground modification [2]. The current exercise involves modifying the native problematic soils' engineering qualities to comply with the design specifications.

The needs of civil engineering can now be modified the soils like soft clays and organic soils. One of the many techniques for soil improvement, the advance review in this area is on soil stabilization techniques.

Normally, lime and cement had been used widely in soil stabilization for construction [3]. However, these stabilizers had experienced an increase in price throughout the years. This is where the waste products are needed to replace those stabilizers, and plastic waste is one of them.

Plastic goods have evolved into a necessity in our daily lives, especially Polyethylene Terephthalate (PET) [4]. The majority of plastic wastes, including PET, are non-biodegradable and unsuitable for combustion because they release toxic gases, making the disposal of discarded material a significant concern [5].

The main objective of this study is to observe the changes that occurred in soil stabilization in terms of strength by using Polyethylene Terephthalate (PET) as a stabilizer. Furthermore, the study encourages reducing plastic pollution in the environment by introducing the way plastic wastes are used in soil stabilization for construction.

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Soil Stabilization

Problems of instability, such as local sinking and the development of slip failure, are present in soft soil [6]. Soft soil has a high organic content and low shear strength [7]. Through the bonding of soil particles, the soil stabilization technique is often used to increase soil strength and decrease soil compressibility.

This technique improves the soil's stability, decreases volume change, and qualifies it for application. This procedure is often utilized when the existing soil is unsuitable for specific applications or when the soil has to be improved because it lacks the appropriate engineering properties. To improve their qualities, several admixtures should be used for this objective [8].

In addition to the advantages and demand of cement, the manufacture of cement clinker is responsible for around 7% of the world's total carbon dioxide emissions [9]. Khan et.al [9] also mentioned that the issues connected to global warming and climate change are caused by carbon emissions.

Therefore, plastic wastes are one of the alternative materials to minimize the problems and at the same time, it is environmentally and economically friendly.

Polyethylene Terephthalate (PET)

Peddaiah, Burman, and Sreedeep mentioned that PET, commonly known as plastic resin and a kind of polyester [2], is made from petroleum hydrocarbons by reacting ethylene glycol with terephthalate acid [10]. Cordoba et.al stated that one of the most popular materials for packaging a variety of items is PET [11].

PET packaging is non-toxic, light, transparent, and highly impact-resistant. It also does not interact chemically with its contents. A significant quantity of PET has been employed in packaging applications; it has gained acceptability and is contributing more and more to the global expansion of PET bottles [10].

The amount used has increased steadily and continuously [12], but with their increasing demand, their disposal is becoming difficult [13]. Despite being a recyclable material, the majority of PET is dumped in landfills or dumped into streams, rivers, and oceans, creating severe environmental, social, and economic issues.

The overall cost of ownership, corporate accountability, a lack of public knowledge, cooperative incentives, and selective collecting are all factors in this circumstance [14]. Therefore, PET used in the geotechnical construction is needed in order to reduce these problems.

Peat Soil Stabilizer

Ahmadinia et.al [18] mentioned that the compressive strength decreased as the amount of PET powder increased. Particularly, when compared to the control sample without PET, the sample with 10% PET powder concentration showed a 74% lower compressive strength [18]. This is brought on by honeycomb and a weakened bond between PET and mortar [16] and the compressive strength of grout decreases considerably when normal PET is used [15].

When waste PET is added, the mixture's tensile strength is reduced. The Tensile Strength Ratio (TSR) values for all the PET-mixes were over 70%, indicating that they might all reach an acceptable level [19]. Poor bonding and lack of treatment may be attributable to a high concentration of heterogeneous dust particles embedded in the PET aggregates [19].

However, the gamma radiation used during the PET irradiation process restores some of the strength that was previously lost as a result of conventional PET. Compared to using regular PET, the PET's improved crystallinity and cross-linking enable cement mortar perform better [9]. When PET is exposed to gamma radiation, the degree of crystallinity rises, producing more closed-packed regions.

Besides replacing cement with fly ash and silica fume improved the compressive strength as well [15]. Due to their pozzolanic qualities, further cement substitution with fly ash and silica fume increased compressive strength and at the same time, this would lead to more waste PET being recycled and used as a cement alternative, increasing sustainability and lowering greenhouse gas emissions [9].

The strength rises for both soaked and unsoaked sample with an increase in the mixture of PET fibre content and fly ash [19] with increases in curing time (7 to 28 days) [11]. The compressive strength was increased by the addition of PET fibres and fly ash as the partial replacement of cement as a result of an increase in cementitious compounds made of calcium silicate hydrate [13];[8].

CONCLUSION

Technically, PET decreases the strength of soil by itself, but it increases the soil strength with the help of the pozzolana materials and whenever the PET is modified. It is clear from the discussion above that it is necessary to use PET wastes collected from various companies around the nation to stabilize the soil. This will immediately contribute to reducing the need for valuable land for their disposal and also decrease the risky environmental effects.

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