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THE USE OF PLASTIC WASTE TO IMPROVE THE PROPERTIES OF CLAY SOIL FOR USE IN PAVING ROADS

[1]Rajaa Mohamed Sager, [2]Saeeda Omran Furgan
Department of roads and runways engineering, Faculty of technical civil aviation and meteorology- Sbaia, Libya
Email: rajaasager0@gmail.com,. saeedaomran.1980@gmail.com

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ABSTRACT

The use of plastic materials such as polypropylene and poly ethylene has faced an enormous increase in the contemporary world. This factor of the contemporary world causes damage to the environment. The world wanted to reuse this waste in a productive way that reduces the ecological damage occurring to the environment. One of the best ways found after numerous researches to reuse this waste, is to utilise them in enhancing the properties of clay soil and further using it in paving roads. This paper focuses on the study that finds the use of plastic waste as the augmentation to improve the properties of soil and decrease the environmental pollution. The soil used in this paper is known to be expansive clay soil by AASHTO soil classification system.

KEYWORDS

Plastic Waste, Soil Properties. Pavement, Roads, Environment

INTRODUCTION

Plastic waste disposal is increasing day by day and has contributed dramatically in ecological hazards. The plastic waste not only causes environmental issues but also eventually leads to financial issues, globally. According to a study conducted, the plastic waste generated on an average level is 15.4 billion pieces on daily basis. Polyethylene terephthalate (PET) and polypropylene (PP) are considered to be the most produced plastic waste in the world. Despite the everyday use of plastic in our lives it creates the huge adverse impact on the society. Therefore, the studies have been conducted in order to fund the effective ways to use this plastic in civil engineering application is to save the

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environment. One of the most effective methods found by the researchers has been the the soil stabilisation to improve the layers of pavement for the roads. The incorporation of plastic waste in the soil helps to make the weak properties of soil into stronger ones. It helps to elevate the availability of UCR, CBR, and MR and reduces the plasticity of the soil. This paper will talk about several aspects of the ways to improve the properties of clay soil to use it in paving roads. Soil reinforcement is the most useful market for HDPE waste.

Keeping all these points in view the paper demonstrates the soil enhancement by the usage of plastic waste products. The objective of this paper is to provide improvement research for the properties of clay soil in a way that reduces the environmental hazards in an economical manner.

RESEARCH METHOD

The procedure carried out to investigate this study consists of the following aspects:

- Specific Gravity
- Sieve Analysis
- Moisture Content
- OMC-MDD
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Furthermore, the sieve analysis, specific gravity, and standard proctor compaction test were conducted for the soil properties analysis. The sieve analysis is a process that is used to evaluate the size distribution among the material with granules. Secondly, specific gravity is the ratio of the unit of solids in the soil to the water unit. There is a specific calculation needed for the ratio calculation, below shown are the degree of saturation and void ratio in the properties of soil.

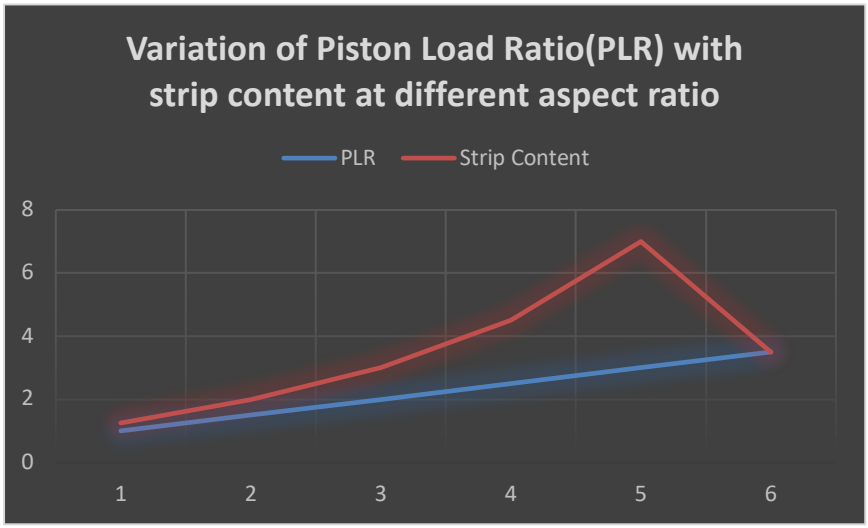
Table 1: Properties of Sample Soil

S.No	Properties Of Soil Sample	Values
1	Specific Gravity	2.12
2	Moisture Content	6.52
3	Optimum moisture content	23.77
4	Maximum dry density	1.64

RESULT AND DISCUSSION

This paper shows how important the enhancement of the clay soil is important to have better-paved roads. It is possible in a way where plastic waste is used in the strips to add them into the soil to gain an alternate way of disposing the waste. The addition of these strips in the soil also makes it the optimum for pavement of roads, as it helps to reduce the value of MDD and increases the value of OMC. The percentage of the plastic strips increases with an increase in the CBR value. Making the soil stable is one of the best ways to dispose of plastic waste without harming nature, this helps in the strength, workability,

and constructiveness of the soil. The addition of plastic in the clay soil further helps towards the improvement of nature of the soil to make roads and the foundation bearing capacity highly enhanced and reliable. It has been studied that the accurate ratio of the soil to be 4% of the plastic strips. The civil engineering structure foundations are highly supported by the soil waste as it supports the structure and provides stability that is needed by the soil. The addition of plastic to the soil is one of the most innovative techniques for stabilisation of soil. Furthermore, the studies show that the monsoon season has different types of effects on paved and unpaved roads, depending upon the quality and the strength of soil. Moreover, HDPE is also used for soil reinforcement for the improvement of engineering properties. To conduct a test, the strips of HDPE were mixed in the soil to find out the actual amount of them available in soil. The results of the test were drawn based on width and the length of these strips. The graph below shows the variation of Piston Loads Ratio which represents that the maximum CBR and the secant module are gained from the ratio of 3 and 4% strip availability. The graph explains that the soil with plastic strips is highly feasible for the pavement of the roads.



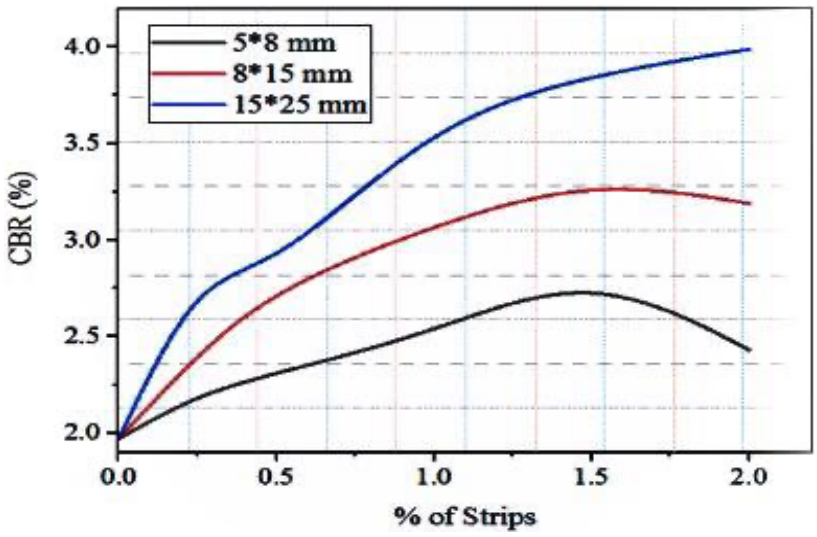
"A Study on Behavior of Waste Plastic Strip Reinforced Soil" Emirates Journal for Engineering Research, 15 (1), 51-57 (2010)

There is a possibility of having some headings for the development of designing properties since geogrids are framed using a polymer sheet that is punched simply. Similarly, Woven geogrids are made by winding around polymer filaments, normally polypropylene or polyester, that can be covered for expanded scraped area resistance. However, welded geogrids are produced by welding the intersecting sections of woven polymers. Likewise, Geogrid composites are crafted by joining geogrids with other items and building a composite framework to suit a specific application. With respect to different kinds of asphalt support applications, expelled geogrids perform particularly well. There is a considerable amount of erosive action on the soil, which reduces the tendency for the soil component to slide between the soil and geogrid component as well as the most frequent way of moving pressure from the soil to the component which supports the soil.

Furthermore, Geogrids tend to interact with soil particles in a variety of ways due to their lack of uprightness. In terms of expansion, geogrids' little solidity makes it plausible to relate the evolution of strength properties of soil to a ductile strain generated by geogrids. By developing fortifications on sub grades, the bank can additionally increase its security coefficient and significantly decrease relocations. Besides, if the powerless sub-grade is balanced or supported, the thickness required at the outside will be less, which results in fewer fixes, and by and large, has a cost-saving effect [1].

At the point when plastic portions of various sizes and rates were added to soil, a decrease in both MDD and OMC was noticed. Abatement in the thickness of asphalt layer materials enjoys a benefit in some design works, like lightweight development. As the level of strips builds, the expanding capability of the dirt altogether diminishes. Assuming that the replacement of a comparable mass of soil with a plastic strip is responsible for this result, further analysis is needed since there are a lot more variables associated with different soil types than just the difference between plastic and soil. Adding plastic waste strips to normally fruitless regions where the same old thing won't develop in the future assists with improving the quality of the soils under the UCS by introducing modern materials into regularly fruitless regions. By contrast with typical soil [non-industrial] mechanisms, yields can be improved more rapidly and more effectively, thus decreasing food costs for nearby residents who rely on ranchers [2].

The site in which the dirt was fully submerged was in the most dreadfully awful condition, Splurged CBR was directed to consider this fact. In addition, this tool is helpful for understanding the impact of water on the strength of broad soils. The graph indicates that CBR worth increases as the size and rate of plastic strips grow. For a 5*8 mm plastic strip, CBR esteem expanded by 44.67% from 1.97 to 2.85; similarly, for 8*15 mm plastic strips, CBR esteem increased from 1.97 to 3.32, while for 15*25 mm plastic strips, it increased from 1.97 to 3.85 [3].



Comparison of CBR values at different percentages and sizes of strip. (Clear Engineering and technology Volume 7 April 2022.)

The density of the soil can be reduced by adding a certain plastic strip to it. A light material (such as soil or sand) is useful to decrease worker fatigue by using less of it. Plastic can also improve the soil's ability to deliver nutrients and retain water, as it can help retain moisture. A study demonstrated that plastic waste strips can be utilised in the settlement of earth banks to reduce fine material substances in the dirt, and therefore, improve its soundness. As a result, the earth particles diminish and the volume of the material diminishes as the waste plastic strips replace fine earth particles. Due to this, the earth's swell tension is reduced. Numerous structural design works, such as lightweight bank development, soil adjustment, and slope stability, can be improved through the use of plastic strips [4].

When soils are balanced out with fibers, the applied burden is to be moved to the frictional point of interaction between soil particles and fibers. Similarly, the soil particles are connected to the filaments through gratings as fiber content increases, thereby increasing the connection points between soil particles and filaments. The soil particles embracing the filaments are unable to change their positions, improving dirt union respectively. As well as maintaining more loads and increasing the soil's UCS, fiber's high elasticity makes it possible to endure more loads. In addition, because PE has a higher degree of elasticity than PP, soils settled with PE exhibit a higher UCS than soils settled with PP. To improve the compressive and elasticity of clayey soils, the researchers used polyethylene waste material (water bottles) as filaments. Among the fiber contents, 0.4%, 0.8%, and 1.2% were found in the dirt dry weight, with fiber lengths ranging from 1.0 cm to 2.0 cm to 3.0 cm. It was observed that the unconfined compressive strength (UCS) of dirt balanced out with fiber was higher than its elasticity. In terms of fiber content and fiber length, 1.2% and 2.0 cm were ideal [5]

It is also common for unpaved and cleared streets to appear poor after rainstorms. An attempt has been made in the review to demonstrate how recycled HDPE can be used as soil support for the design of sub grade soil properties. The strips obtained from squandering plastic of various aspects were blended haphazardly with the soil to determine the amount of HDPE strips. Using the ratio of length to width of the strip, they conducted tests and deciphered the information. Added to that, the scholar pointed out that since most plastic sacks are made from high-thickness polyethylene material, therefore the amount of plastic material in the environment is rapidly expanding [6].

Test	Standard	% Used of steel slag
Plasticity	ASTM D4318	0, 5, 15, 30
Unconfined compression	ASTM D2166-85	0, 5,10, 15, 20, 30
Direct shear	ASTM D3080-90	0,15, 30,100
Free swell	ASTM D4546-90	0, 5,10, 15, 20, 30
CBR test	ASTM D1883-87	0, 15, 30
Compaction	ASTM D698, D1557	0, 15, 30
Specific gravity	ASTM D854	0
Grain size analysis	ASTM D422	0
Classification of materials (USCS)	ASTM D2484	0

Effect of by-product steel slag on the engineering properties of clay soils.

(Testing program of the stabilised clay soil Volume 29, Issue 4, October 2017, Pages 394-399)

CONCLUSION

In a nutshell, we can say that paving roads with substances such as asphalt, concrete, and brick is the most significant way to make the roads less vulnerable to annihilation in extreme weather circumstances such as rain and snow. Moreover, the roads are not impervious to damage but they can tolerate the extreme weather conditions as argued by experts. It is remarkably effective to strengthen and protect roads by using plastic waste as paving. In order to produce quality paving materials, the soil in which the paving product is created is a key element. Similarly, suitable paving materials are produced when the soil is of sufficient quality and quantity for the area, they are being used. Rainy areas, for example, need soils that can withstand the absorption of water and remain stable despite these conditions. Using plastic waste in combination with clay soil, to make paving material appropriate for this type of application. In addition to improving the soil quality, plastic waste helps to improve the soil by filling in the gaps in the soil. In this way, clay soil properties can be improved and plastic waste can be recycled.

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