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Stabilisation of Soil using PET Bottle Strips and Coir Fiber: A Review

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Abstract-With rapid advancements in technology globally, the use of plastics such as polyethylene bags, bottles etc. is also increasing. The disposal of thrown away wastes pose a serious challenge since most of the plastic wastes are non-biodegradable and unfit for incineration as they emit harmful gases. Soil Stabilisation improves the engineering properties of weak soils by controlled compaction or adding stabilizers like cement, lime etc. but these additives also have become expensive in recent years. Experimental investigation on reinforced plastic soil results showed that, plastic can be used as an effective stabilizer so as to encounter waste disposal problem as well as an economical solution for stabilizing weak soils. In many civil engineering constructions, soft and weak soils are often stabilized with Ordinary Portland cement (OPC) and lime. Plastic strips and coir fibre with its high strength, low cost, offers a promising alternative to OPC, significantly less dangerous for the environment as compared to many chemical solutions .The combined effect of plastic bottle strips and coir fibre and can enhance the engineering performance of the soil.

Key Words*: *PET bottle strips ,coir fibre, clay, Stabilisation.

1. INTRODUCTION

Soft soil possesses low strength and undergoes excessive volume changes, making its use in the construction activities very difficult. The properties of the soft soils may be altered in many ways viz, mechanical, thermal, chemical and other means. Modification of soft soils by chemical admixtures is a common stabilisation method for such soils. Among various admixtures available, lime, fly ash, cement are most widely and commonly used for the stabilisation of soft soils. Clay needs to be improved before it can be used in embankments, canal, roadway, dams, waste landfills etc. Clay soils feel very sticky and rolls like plasticine when wet. They can hold more total water than most other soil types and, although only about half of this is available to plants, crops seldom suffer from drought. They swell when wetted and shrink when dried, so a certain amount of restructuring can take place in these soils depending on weather conditions. Method of stabilisation by mixing soil with stabilizing agents or binders have been well established to improve engineering properties of the ground which results in improved bearing capacity and reduced settlements under imposed loads. Plastics are considered as one of the important invention which has remarkably assisted in different aspects of life whether it might be in scientific field or others. But now, plastic has become the significant pollutant of environment because of the use and throw mechanism. Coir or coconut fibre belongs to the group of hard structural fibres. It is an important commercial product obtained from the husk of coconut.The coir fibre is elastic enough to twist without breaking and it holds a curl as though permanently waved. The inclusion of fibres had a significant influence on the engineering behavior of soil-coir mixtures. The addition of randomly distributed polypropylene fibres resulted in substantially reducing the consolidation settlement of the clay soil. Length of fibres has an insignificant effect on this soil characteristic, whereas fibre contents proved more influential and effective. Addition of fibre resulted in decrease in plasticity and increase in hydraulic conductivity

2. STABILISING SOILS WITH WASTE PLASTIC BOTTLE STRIPS AND COIR FIBER

Plastic products have become an integral part in our daily life as a basic need. It is produced on a massive scale worldwide and its production crosses 150 million tonnes per year globally.

Bhattarai Pragya, et.al (2013) conclusion in the aspect of strength CBR and the Aspect ratio is increased then the strength parameter is also increased. Aspect ratio of 3mm and adding 0.5% of plastic bottle strips by the weight of soil it can be used for stabilisation of soil of embankment, pavement and subgrade.

Amit Kumar Rai et.al (2020) Their use as reinforcing materials for weak soils to improve its strength is a way of recycling these materials in a meaningful, efficient and cost-effective manner. Their applications in soil stabilisation of base, subbase courses of pavement, reinforcements for earthen embankments and to reduce the settlement of soil in foundations are some examples of using these materials for civil engineering purposes.

D Brett martinson et.al (2015)coir fiber can be used in soil improvement as a replacement for other expensive admixtures like cement, lime etc. as coir is a cheaper alternative., if locally available soil is inadequate to support design maximum loads, the properties can be improved by soil stabilisation techniques by adding suitable additives.

Leema peter et.al (2014)The coir waste was obtained in a soaked state which was then sundried to reduce its moisture content to zero.varying coir pith content in the range of 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0% and coir fibre content by 0, 0.2, 0.4, 0.6, 0.8, 1.0% of dry weight of soil This paper presents a study on the behaviour of soil stabilized with varying percentages of coir pith (0-3%) and coir fibre (0-1%) by

carrying out laboratory tests.The results of test showed that stabilization with coir fibre waste had a significant effect on the compaction. Elastic modulus as well as CBR characteristics.

3. LITERATURE REVIEW

Amit Kumar Rai et.al (2020) E-Waste-MDD increased upto 5% and starts decreasing gradually with more addition of sample, UCS value keep increasing at a rate of 2 KN/mt2 with addition of fixed percentage of waste, CBR value keeps increasing with addition of E-waste. Plastic Waste -Maximum value of MDD will be obtained at 6% and after that MDD value will get starts decreasing .UCS value will be increased up to 6% and after that gradual decrease will be shown with the addition of more plastic waste. Maximum soaked CBR value will be obtained at 6%. And after that gradual decrease will be observed with more addition of plastic waste. Waste Glass Powder-Highest value of MDD will be obtained at 4% and its least value was recorded at 6%, Maximum value of UCS was recorded at 4% with the application of 0.6 mm axial strain, CBR-Peak values was obtained at 6% addition of glass powder and the results shows that 95% value will get increased.

Alaka raj et.al (2014) .The CBR value was increased by192% and 335 % for 2% coir pith and 0.6 % of short coir fiber addition, and the combined treatment increased the CBR by 4.6 times. The E-value for the combined treatment increased from 7.92MPa to 9.66 Mpa.The effective use of coir waste can uplift rural economy and leads to beneficial effects in engineering construction.

A.Ayyappan et.al (2018) Adding plastic strips into the soil, there has been a positive impact on properties of soil and increases the bearing capacity of the red soil. Use of plastic as a soil stabilizer in road soil sub-grade can be recommended as it increases the CBR value and make the soil stable .It has been found that the maximum CBR is obtained when the waste plastic isadded up to 0.75% but the coir fiber stabilized the soil is lesser.

Arul rajah et.al (2019) Cement stabilized polyethylene terephthalate (PET) blends with construction and demolition (C&D) waste, namely recycled concrete aggregate (RCA) and crushed brick (CB), as a pavement construction material. This study shows that 3% cement stabilized 5%PET + 95%RCA and 5%PET + 95%CB can be utilized in constructing pavement bases and sub bases which can substitute the virgin quarry material used in such applications.

Burman et.al (2016) 0.4% plastic content with strip size of (15 mm x 15 mm). It is found that MDU and OMC values of silty sand are 16.75 kN/m3 and 16.8%respectively. Direct Shear test, the cohesion and angle of internal friction for natural soil are 19 kN/m2 and 23.2◦.The CBR value for natural soil obtained is very low at 3.2%. It is observed from the study that, improvement in engineering properties of silty sand is achieved at 0.4% plastic content with strip size of (15 mm

B.Joseravindraraj et.al (2018) Adding plastic strips into the soil, there has been a positive impact on properties of soil and increases the bearing capacity of the red soil. Use of plastic as a soil stabilizer in road soil sub-grade can be recommended as it increases the CBR value and make the soil stable .It has been found that the maximum CBR is obtained when the waste plastic is added up to 0.75% but the coir fiber stabilized the soil is lesser.

G.L. Siva kumar Babu et.al (2010) It is observed that the peak shear stress during shearing for plain red soil is 65 kPa, whereas1.0% plastic waste mixed soil, it reaches to 113 kPa. The results indicates that there is 73.8% increase in unconfined strength for 1% similarly 1.0% plastic waste mixed sand it is reaches to 31 kPa the increase in strength is 93.70% over that of plain sand. It is noted that compression index for 1.0% of plastic waste mixed soil is reduced by 37.2% as compared to plain red soil. In case of sand the reduction in compressibility indices for 1.0% plastic waste mixed sand is 26.6% as compared to that of plain sand. stress–strain and pore water pressure for plain soil and plastic waste mixed soil at confining pressure of 100 kPa Recycling plastic waste from water bottles has become one of the major challenges worldwide.

D Brett martinson (2015) The coconut fiber aspect ratio that could produce the maximum compressive and tensile strengths of soil blocks may be 125 or higher. In terms of linear dimension, it translates into length of 50 mm or higher of the coconut fiber. This produced about 25% improvement in compressive strength and more than half in tensile strength over the smallest fiber aspect ratio. The highest available aspect ratio of 100 for oil palm fiber recorded the highest value for both compressive and tensile strengths. This aspect ratio was equivalent in length to 38 mm. There was about 20% improvement in peak compressive and tensile strengths over the smallest aspect ratio. There was a strong linear relationship between compressive and tensile strengths of the enhanced soil blocks for each of the fiber aspect ratio for each fiber type.

Humphrey Danso et.al (2019) The addition of 0.2% coconut fiber and 5% lime contents in the soil-cement mortar gained the highest density. This implies that coconut fibers and lime in soil-cement fairly influence the density of the composite material. Both the compressive strength and the tensile strength of the soil-cement mortar achieved optimum strength at 0.2% coconut fiber and 5% lime content. Implying that, the 0.2% coconut fiber and 5% lime provide better strength properties of the mortar

JN Mandal et.al (2015) Water bottles can be available with different diameters. Cells made with used waste plastic water bottles and filled with proper infill material can carry huge compressive load before failure as well as can sustain

very large strains. In compression tests, plastic bottles not only sustain 30%-40% axial strain before failure but also it fails at a high compressive pressure of 4000 kPa to 5000 kPa. It suggests that these materials can be used for supporting higher loads as well as can permit higher settlements if required.

Mamta Mishra et.al(2016). Concluded that the reinforcement of soil mixed with fly ash further increases the strength of soil used for construction activity. Reducing the cost as well as energy. Both the length and content of coir have important role in developing the strength properties of stabilized soil. But the strength properties are mostly affected by coir content than by size of coir fiber. The CBR value increase from 130.11% to 207.11% from addition of 16% of fly ash, 0.75% coir fiber.

4. CONCLUSIONS

There is significant improvement in the strength of soil with inclusion of plastic waste.

1) Increase in strength of soil is due to increase in friction between soil and plastic waste and development of tensile stress in the plastic waste.

2) Compression behavior of plastic waste mixed soil indicates significantly reduction in compression parameters

3) Coconut fiber achieve 25% improvement in compressive strength and more than half in tensile strength over the smallest fiber aspect ratio.

4) It has been found that the maximum CBR is obtained when the waste plastic is added upto 0.75%

5)Cells made with used waste plastic water bottles and filled with proper infill material can carry huge compressive load before failure as well as can sustain very large strains 30%-40% axial strain before failure but also it fails at a high compressive pressure of 4000 kPa to 5000 kPa.

6)The CBR value was increased by 192% and 335 % for 2% coir pith and 0.6 % of short coir fiber addition, and the combined treatment increased the CBR by 4.6 times.

7) 0.2% coconut fiber and 5% lime should be used by practitioners to stabilized soil-cement mortar for construction application.

8) SEM analysis of the specimens indicated that the surface of the coconut fibers was rough.

9) The 0.2% fiber content specimen had each fiber covered with a soil-cement matrix which resulted in increased friction of the fibers and the matrix, ensuring increased strength.

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