Strategies to Stabilize Soil Using Plastic Waste Reinforcement Strip

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Abstract— Due to Economic Growth, Changing Consumption and Production Patterns, there is a rapid increase in generation of waste plastics all around the world. This study investigated the possibility of utilizing waste fiber to reinforce soils to pave way forits use in civil engineering projects such as in road bases, embankments and slope stabilization. The main objective of this study is to investigate the use of plastic waste materials in geotechnical applications and to evaluate the effects of waste polypropylene fibers on shear strength of the unsaturated soil by carrying out shear tests and unconfined compression tests on two different soil samples. Laboratory results obtained favourably suggest that inclusion of this material in alluvial soils would be effective for subgrade improvement in geotechnical engineering.

KEYWORDS: Soil Stabilisation, Fibres of Waste Plastics,Polythene plastic waste;
Construction Materials, Waste material.

I. INTRODUCTION

Soil pose serious challenges in construction of lightly loaded civil engineering structures, like residential houses as well as major infrastructural projects like highways, railways, water Reservoirs etc. For any land-based structure, the foundation is very important and has to be strong to support the entire structure. The problem fundamentally arises from the fact that soils (that mostly contain montmorillonite and kaolinite as clay minerals) show seasonal variation in their volumes due to variation in available soil moisture. Soil expand in volume when the moisture is abundantly available and shrink (even forms wide cracks at times) when there is inadequacy of moisture and these volumetric changes give rise to the changes of differential settlement, which is a serious detriment to the foundation of any Civil Engineering structures. This differential settlement subsequently causes damage to the structural stability and aesthetic features of the structure as a whole. So while tackling such challenges researchers have arrived at a broader consensus of stabilization of soils using certain additives for its treatment. Stabilization of soil can be done in number of ways. But the stabilization using waste plastic fiber is an economic method since the stabilizer used here is waste plastic fiber materials, which are easily and cheaply available. This paper presents the various tests conducted on reinforced soil with varying fiber content and different aspect ratio. Therefore, it is great importance to consider the design and construction methodology to maintain and improve the performance of such pavements. Due to growing concern about the disposal off plastic waste and the panic in the current environment, the object of this paper was chosen as "Soil Stabilization Using Polypropylene as Waste Plastic Fibre Material" which is one of the type of the plastic fiber waste. In this research work, an extensive laboratory work have been done to investigate the use of the waste fibre of the polypropylene for the improvement of the various properties of the Clayey (CL) type of soil.

Figure 1: Plastic Bag

II. LITERATURE REVIEW

Shish Pal , Vinod Kumar Sonthwal , Jasvir S Rattan, (2015): The focus of the paper is to review the effectiveness of using Waste plastic fiber as a reinforced to enhance the lime properties of soil. The paper presents the influence of different mix proportions of plastic fiber on compaction, strength properties, CBR values and durability characteristics of soil. The results shows that addition of plastic fiber not only improves the strength development but also enhance the durability of stabilized soil.[1]

Miss Apurva J Chavan (Apr-2013) : "Use of plastic waste in flexible pavements." Disposal of waste fiber materials, including waste plastic bags has become a grave trouble and waste plastics arc burnt for apparent disposal which cause environmental contamination. Use of waste plastic bags in bituminous mixes has proved that these enhance the properties of mixtures in addition to solving disposal problems. They used Plastic waste which is cleaned and cut into a size such that it fades through 2-3mm sieve using shredding machine. The aggregate mix is heated and the plastic is effectively coated over die aggregate. This plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used in road construction. The use of the innovative- technology will not only strengthen the road

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construction pavement but also increase the road life as well as will help to improve the environment.

R.N.Nibudey et al.; (2013): "Strength Prediction of waste plastic fiber reinforced concrete (M30)."Now a day we are facing environment protection problems Many things which are formulated for our luxurious life are responsible for polluting environment due to improper waste management technics.One of them is a plastic waste which holds lo be discarded or recycled properly to preserve the beauty of nature. To address this problem the fibers from used plastics were added in various parts in the M30 grade concrete. This paper identifies the performance of plastic fiber reinforced concrete (M30). An experimental study has been taken out on the specimens like cubes and cylinders which were cast in the laboratory and their behavior under the test was observed. The waste plastic fibers were added from 0.0 % to 3.0 %. The compressive and split tensile strengths of concrete were found after 28 days curing period.

Rabindra Kumar et al.; (2012) : "Plate load rest on fiber-rein forced cohesive soil." This paper discusses the load settlement response from three plate load tests (0.3m × 0.3m square 25 millimeter deep) carried out on a thick homogeneous stratum of compacted cohesive soil, reinforced with randomly distributed polypropylene fiber and coir fiber as well as on the same soil without the reinforcement. The plate load test on the soil-fiber layer was performed to relatively high pressures, and yielded a noticeable stiffer response than that carried out on the unreinforced stratum. It is concluded from plate load tests that the settlement under a particular load in unreinforced soil is much more compared to the reinforced soil, minimum settlement being observed for the soil reinforced with polypropylene fibers. The ultimate load for the unreinforced soil is found to be 42 KN and the values for soil reinforced with coir fibers and polypropylene fibers are 70 KN and 80 KN respectively. There are number of other uses of Waste plastic fiber, which are still in the research stage, such as plastic reinforcement concrete, to get resolve from the problem of dispose of it, as a plastic fibers are good reinforcement agent for tiles manufacturing also, earthquake resistive elements and so on.

Jigisha M. Vashi 1, Atul K. Desai2, Chandresh H. Solanki2 (2012): A parametric study is carried out to analyzing reinforced embankment on soft soil using the applicability of limit equilibrium method in this paper. The effect of vertical spacing of slope inclination ,geotextile layers and PP (Polypropylene) geotextile behavior and tensile strength of PET (Polyester) on reinforced fly ash and clay mixed embankment over a soft clay layer is studied. For present investigation , a 8 m high embankment with 20 m crest width and slopes of 58°, 64°, 72°, and 78° are consider. After modeling the above standard geometry, software version 12 was using the GEO5 – slope stability. Results shown that use of full length of geotextile covering and width of embankment can increase factor of safety (F.S) at steeper slope inclination. For safer designs also decreasing the slope inclination and vertical spacing of geotextile.From this study it is seen compared to PP geotextile the reinforced embankment with PET geotextile gives economical and safe design, when the creep phenomenon is considered as a governing factor.[12]

Kalumba D., Chebet F.C. : This study investigated the possibility of utilising polytheylene shopping bags waste to reinforce soil to pave way for its use in civil engineering projects such as in slope stabilisation ,road bases, embankments . A no. of direct shear tests was undertaken on soil-plastic composites of two selected sandy soils: Klipheuwel and Cape Flats sands. Strips of shredded fiber material were used as reinforcement inclusions at concentration of up to 0.3% by weight. By using strip length from 15 mm to 45 mm and strip widths from 6 mm to 18 mm, the effect of varying dimensions of the strips was investigated. To identify the soil improvement shear strength parameters were obtained for composite specimen. The testing programme involved addition of perforated strips as well as solid strips with varied diameter of perforations to examine the effect of the openings on the strips. Laboratory results obtained favourably and suggest that inclusion of this material in sandy soils would be effective for ground improvement in geotechnical engineering.

Mercy Joseph Poweth,Femeeda Muhammed Haneef*,Melvin T Jacob*,Remya Krishnan*,Sheethal Rajan* :** This work presents a study on the effect of plastic granules on the properties of soil. Utilizing the waste plastic as granules in the soil solves the problem of disposing the waste and it does not show any considerable reduction in the strength of soil. Experiments were done by taking an available weak soil as sample. These tests are conducted on soil with varying percentage of plastic granules and without adding it and comparing those results. Data presented includes dry density, shear strength, CBR value, permeability. The experiment reveals that properties of the soil does not change considerably. The proposed technique can be used as an effective method to dispose the waste plastic.

Anas Ashraf, **Arya Sunil**,**J. Dhanya**, **Mariamma Joseph Meera Varghese**,**M. Veena :** Soil stabilisation is a process which improve the physical properties of soil, such as increasing shear strength, bearing capacity etc. which can be done by use of controlled compaction or addition of suitable admixtures like cement, lime and waste materials like fly ash, phosphogypsum etc. The cost of introducing these additives has also increased in recent years which opened the door widely for the development of other kinds of soil additives such as plastics, bamboo etc. This new technique of soil stabilisation can be effectively used to meet the challenges of society, to reduce the quantities of waste, producing useful material from non-useful waste materials. Use of plastic products such as polythene bags, bottles etc. is increasing day by day leading to various environmental concerns. Therefore the disposal of the plastic wastes without causing any ecological hazards has become a real challenge. Thus using plastic bottles as a soil stabiliser is an economical utilization since there is scarcity of good quality soil for embankments. This project involves the detailed study on the possible use of waste plastic bottles for soil stabilisation. The analysis was done by conducting plate load tests on soil reinforced with layers of plastic bottles filled with sand and bottles cut to halves placed at middle and onethird positions of tank. The comparison of test results showed that cut bottles placed at middle position were the most efficient in increasing strength of soil. The optimum percentage of plastic strips in soil was found out by California Bearing Ratio Test and using this

percentage of plastic, plate load test was also performed. The size and content of strips of waste plastic bottles have significant effect on the enhancement of strength of the soil.

Wajid Ali Butt[1]*, Karan Gupta[2], Hamidullah Naik[3], Showkat Maqbool Bhat: Accumulation of solid waste requires a large area for its disposal. Human hair fiber (HHF) a non- degradable matter is creating an environmental problem so its use in soil improvement can minimize the problem. Also human hair fiber available in abundance at a very low cost. The main purpose of this research is to understand and investigate the variations in the strength of the cohesive soils using human hair fibers (natural fiber) as a soil reinforcing material. The study also includes the determination of the optimum reinforcement in terms of fiber content and length. The HHF randomly mixed in clayey soil samples were tested for its engineering property (Strength) by performing CBR tests on a number of samples by using the different percentage of fibers and comparing the results with the non-reinforced soil. Fibers of different length and equivalent diameter were used with an aspect ratio ranged from 295 to 500. The test result reveals that the strength significantly improves with the inclusion of HHF and also prevents the sample from cracking. Moreover an environmental concern is also included by utilization of waste human hair fiber materials and they can be made useful for improving the soil characteristics and to solve the problems related to the disposal of waste human hair fibers material.

Shaheer Khan, Syed Jafar Shah, Umair Ayub, Haziq Khan(2014): Polythene plastic waste is a growing threat as it takes more than 500 years to decompose, in some cases up to 2000 years i.e. non-biodegradable. Secondly, oil-contaminated soils due to oil spillages have not been studied extensively from a geotechnical perspective. This paper merges and studies the two problems simultaneously by working out an approach to reinforce the soil in both (virgin and oil contaminated) conditions using plastic waste as a reinforcing material . The paper aims to compare and stabilize two different kinds of soil (well-graded gravel and clayey soil) under two different conditions (virgin and oil-contaminated condition) using waste polythene plastic. Soils were incorporated with different proportions of plastic waste and were tested for their performance based on the changes in their geo-technical properties predominantly, shear strength and hydraulic conductivity. The improved properties of soil due to plastic introduction under both conditions (contaminated and uncontaminated) paves a way for solving the problem of plastic waste management while on the other hand reinforces the soil by improving the quality (bearing capacity and hydraulic conductivity) of not only ordinary soil but that of oil-contaminated soil too. More than a 100% increase in shear strength was recorded while hydraulic conductivity of soils was reduced up to 1.5 times on average and in some cases a decrease up to 5 times was recorded. The optimum plastic content (to be incorporated in soil) ranged between 0.2%-0.25% for different kinds of soil under both virgin and oil-contaminated conditions.[13]

Dhiren R Hasrajani1, Anuj K Shah1, Aditya M Patel1, Jay P Panchal1, Alka M Shah2: The term soil stabilization means the improvement of the stability or bearing power of the soil by the use of controlled compaction, proportioning and the addition of suitable admixture or stabilizer, but the stabilization using waste plastic is an economic method as they are easily and cheaply available. This paper presents the CBR test conducted on fine sand reinforced with randomly distributed polypropylene fibers, under both soaked and unsoaked conditions with varying fiber content. Results of CBR tests demonstrate that inclusion of polypropylene fibers in sand with appropriate amounts improves strength and deformation behaviour of sub grade soils .The fiber addition rate varies from 0% to 2.5% at 0.5% interval. In this paper CBR value of reinforced sand increases by 113% compared to unreinforced sand. The optimum fiber content was found to be 2.5% (w/w). The addition of fiber becomes impractical after 2.5%.The proposed technique can be used in embankment, road construction, industrial yards etc**.**

Figure 2: Shredded and perforated strips

III. NEED FOR PRESENT & FUTURE STUDY

The review of literature shows that waste fiber material are a versatile material with attractive characteristics and advantages, as a result of this waste fiber material is now being used abundantly all over the world. Waste plastic fiber are high strength, low cost, long life and non biodegrable material. Therefore they are used for increasing the engineering properties of soil and may also be used for control of seepage. The use of waste fibres plastics will results in decreasing the environmental impacts and it will also reduce the requirement of valuable land for the disposal of wastes and it will also.

IV. STRATEGIES FOR SOIL STABILIZATION

From the beginning of construction work, the necessity of increasing the soil properties has come to the light. Various strategies to improve soil strength etc., some of these strategies were so effective that their buildings and roads construction.

V. UTILIZATION OF POLYETHYLENE (PLASTIC) SHOPPING BAGS WASTE FOR SOIL IMPROVEMENT IN SANDY SOILS

This study explored the possibility of utilize reclaimed plastic material from polyethylene bags as tensile inclusions to reinforce soil for ground improvement schemes in geotechnical engineering applications such as retaining walls,road bases, embankments and slope stabilisation.

VI. SOIL STABILIZATION WITH FLYASH AND RICE HUSK ASH

Fly ash was successfully used for stabilize expansive clays. For upgrade expansive soil properties as a construction material using RHA and fly ash, which are waste materials.

VII. UTILISATION OF PLASTIC WASTESIN STABILISED MASONRY BLOCKS

Their employability in mud block making in the form of fibres (waste plastic fibre- mud blocks) can be investigated. Also, the review of most studies on natural fibres are focussed on vegetable fibres /cellulose based obtained from renewable plant resources except in very few cases, where animal fibre, polystyrene fabric and plastic fibre were used.

CONCLUSION

From the above discussion it can be concluded that there is a need to utilizing the waste fibre material to obtained from the various industries across the country for stabilization of the soil. which will directly help in decreasing the hazardous environmental impacts and also decline the requirement of valuable land for their disposal

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