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Utilization of waste rubber tyre in soil stabilization

Anjali Singh[1], Divya Ratre[2], Tarika Shrisant[3], Anjali Kerketta[4], Deeksha Chandrakar[5], Dr. Ajay Kumar Garg[6]

[1,2,3,4] Department of Civil Engineering, Government Engineering College Raipur, Chhattisgarh, India.
[5]Assistant professor, Department of Civil Engineering, Government Engineering College, Raipur, Chhattisgarh, India.
[6]HOD, Department of Civil engineering, Government Engineering College Raipur, Chhattisgarh, India.

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Abstract*: This paper explores the feasibility and benefits of utilizing waste rubber tyre for soil stabilization purpose.With the growing environmental concern surrounding waste tyre disposal, repurposing them for soil stabilization presents a sustainable solution. Added amount of rubber tyre had been varied in proportions of 10%, 15%, 20% and 25%.Waste rubber tyre helps in improving the desired properties of soil and minimizes the amount of waste to be deposited in environment causing environmental pollution. Rubber tyres are cost effective and is quite easily available, due to day by day increase in cost of stabilizers like cement, lime and other admixtures;use of shredded rubber tyre can result in project completion optimally. The soil sample used is clay, thus being highly plastic it is required to be strengthened by using varying proportion of shredded rubber tyre. The effect of shredded rubber tyre on soil is analysed by conducting various tests that governs the basic properties of soil and the obtained result shows that increasing the percentage of shredded rubber tyre results in enhancement in desired soil properties.Increase specific gravity, increase liquid limit, and decrease plastic limit are achieved through the incorporation of appropriate additives in soil stabilization processes.*

Key Word: *Waste rubber tyre, Soil stabilization, Tyre recycling, shredded rubber tyre, Engineering properties, clay soil.*

I.INTRODUCTION

Soil stabilization means the improvement of stability or bearing power of the soil by the use of controlled compaction, proportioning and/or the addition of suitable admixture or stabilizers. The basic principles of soil stabilization are: a. Evaluation of the properties of given soil. b. Deciding the lacking property of soil and choose effective and economical method of soil stabilization. c. Designing the stabilized soil mix for intended stability and durability values. The soil often is weak and has no enough stability in heavy loading. The aim of the study was to use the waste material for stabilization of soil in order to reduce the environmental impact. Stabilization can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load bearing capacity of a sub-grade to support pavements and foundations. Stabilization can be used to treat a wide range of sub-grade materials from expansive clay to granular materials. The most common improvements achieved through stabilization include better soil gradation, reduction of plasticity index or swelling weather, stabilization may also be used to provide a working platform for construction operations. These type of soil quality improvements are referred to assoil modification. Benefits soil stabilization are higher resistance values, reduction in plasticity , lower permeability reduction in pavement thickness , elimination of excavation , material hauling and handling, and base importation , aids compaction, provides all-weather access onto and within project sites. As good soil becomes scarcer and their location becomes more difficult and costly, the need to improve quality of soil using soil stabilization is becoming more important. This paper aims at studying the appropriateness of shredded rubber tyres for its use in pavement engineering, i.e. to stabilize the subgrade of the Pavements. It can significantly enhance the properties of the soil used in the construction of road infrastructure. Clayey soil holds water much better than sand, though prone to water logging which results in settlements of road embankments and structures.

II.LITERATURE REVIEW

Ghatge Sandeep Hambirao, Dr.P. G. Rakaraddi found that he tests have clearly shown a significant improvement in the shear strength and bearing capacity parameters of the studied soil. The results obtained are compared with un reinforced samples and inferences are drawn towards the usability and effectiveness of fiber reinforcement as a replacement for deep or raft foundation and on pavement sub grade soil as a cost effective approach. The low strength and high compressible soft clay soils were found to improve by addition of shredded rubber and cement. It can be concluded that shredded rubber fibre can be considered as a good earth reinforcement material.[3]

Umar Jan, Vinod K. Sonthwal, Ajay Kumar Duggal, Er. Jasvir S. Rattan, Mohd Irfan The optimum moisture content as well as maximum dry density is found to decrease with the increase of the percentage of rubber tyre content. This might be due to light weight nature of tyre waste.The percentage enhancement in CBR value of stabilized soil is 66.28 percent in unsoaked condition whereas an increase in CBR value can considerably trim down the total thickness of the pavement and hence the total cost concerned in the project. [4]

C.N.V.S. Reddy and K.D. Rani concluded that soil tyre chip mixes can be used for highway and railway embankments constructions and for preparations of improved subgrades.Addition of small percentage of tyre chips by weight to aggregate results in improved toughness and reduced wear and tear. [7]

H. L. S Sathik, D. De S. Udakara Tyre chips mixed with soil showed maximum CBR as 2.35\% at 6\% rubber chips content. It shows that the percentage improvement in CBR value in stabilized soil is 43.3\% in soaked condition. An increase in CBR value can significantly reduce the total thickness of the pavement and hence the total cost involved in the project.[10]

Soni and Sagane (2014) studied the use of shredded rubber tyres in embank construction. Tyre shredded can be used to construct embankment on weak,compressible foundation soils. The authors opined that tyre shreds were viable in those application due to their light weight. The weight of the tyre shreds reduce horizontal pressure and allow for construction of thinner, less expansive walls.[11]

Sanjeev Singh, Umesh Dhiman, Rubel Sharma concluded that Largely, there is an increase in the value of unconfined compressive strength due to increase in percentage of tyre scrap of various sizes indicating strength improvement of soil. There is no significant variation in the values of strain at failure, but normally there is a decrease in the values due to increase in percentage of tyre scrap of various size. [2]

III.MATERIAL AND METHODOLOGY

Clayey soil:

Clayey soil has been collected nearby from DC Club, Old Dhamtari road. Clayey soil are found over 16% of the total area of the country and in Chhattisgarh state it is found in Raipur ,Ballarpur , Durg and Korba zone

Shredded tyre:

The shredded tyre is collected from Chand tyres,K.K Road ,Moudhapara , Raipur(C.G.).The shredded tyre used is of size 2-3 mm in length(maximum) and thickness ranging from 1-2mm and they don't have any steel wire or nylon fibre.

Methodology:

various tests such as liquid limit, plastic limit ,specific gravity and dry density has been performed that provides a comprehensive understanding of the change in physical, mechanical, durability and engineering properties for soil as well as for soil-tyre mix (10%,15%,20%.25% of soil mass) .By understanding how the index properties of soil tyre mix changes and its influence on various soil behaviors, the soil stabilization process is optimized ensuring the long term performance and durability of soil stabilized structure.

Plastic limit test:

Representative soil sample altogether with shredded tyre in various percentages is mixed with distilled water to form paste is rolled into a thread of uniform diameter until it crumbles at a diameter of about 3mm.This is the plastic limit.Record the water content at the plastic limit.

Liquid limit test:

Soil sample is mixed with tyre and water to form a thick paste and placed paste in a cup of the liquid limit device. A groove is created using grooving tool .water is gradually added and continue to groove until the soil flow along the groove for a distance of 12.7 mm (1/2 inch) using a standardized device. Water content recorded at this point is used for liquid limit determination.

Specific gravity test:

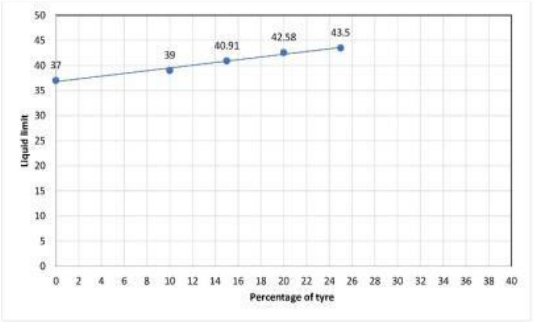
a clean, dry flask and record its mass (M1).the flask is filled with distilled water and its mass is recorded (M2) a sample of dry soil is weighed along with shredded tyre and record its mass (M3).Place the soil sample in the flask with water and record the combined mass (M4).

Dry density :

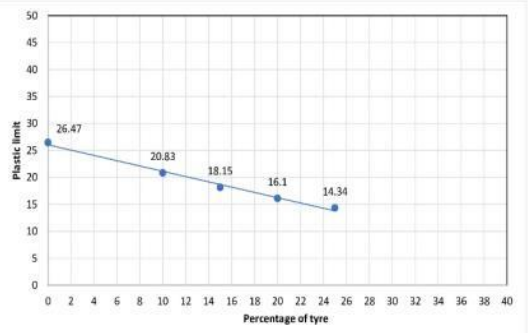
The dry density test by core cutter method determines the in-situ density of soil.Drive a metal core cutter into the soil to obtain a cylindrical sample.Extract the sample carefully without disturbing its structure.Measure the dimensions (diameter and height) and mass of the sample.Calculate the volume of the sample.Determine the moisture content of the sample using appropriate formula.

IV.RESULT

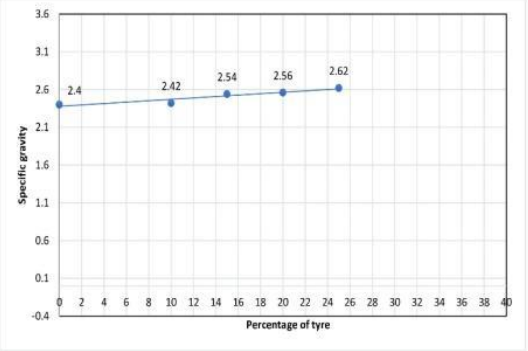
Various test is conducted on soil and soil-shredded rubber tyre mixtures to determine its Engineering properties, namely liquid limit, plastic limit, specific gravity and Dry density. The soil is mixed with tyre shreds of 10%, 15%, 20%, and 25% By weight of soil. The values obtained are shown in the graphs below:



Liquid limit test



plastic limit test



Specific gravity test

V.DISCUSSION

Shredded waste rubber tires are ground up into small pieces and mixed with soil to make it stronger and more stable for construction projects. Instead of letting old tires sit in landfills or burn them, we can recycle them by shredding them into pieces. Mixing these pieces with soil improves its properties, making it better for building roads, embankments, and other structures. When mixed with soil, shredded rubber provides additional support and flexibility, making the ground more resistant to erosion, cracking, and settling. This helps structures built on it last longer and perform better. Recycling shredded waste rubber tires for soil stabilization is environmentally friendly and cost-effective. It reduces waste in landfills, cuts down on the need for new materials, and saves money in construction projects .While using shredded waste rubber tires can bring many benefits, there are challenges to consider, such as finding the right balance of rubber-to-soil ratio, ensuring proper mixing, and assessing the long-term durability of the stabilized soil.

VI .CONCLUSION

The present research work aimed to utilize shredded rubber tyre in soil stabilization and the following conclusions are drawn:

1. The liquid limit test on soil with shredded rubber tyre shows an increasing trend with increase in percentage. The increasing liquid limit implies that shear strength of soil increases and soil becomes more stable with an increase in percentage of shredded rubber tyre.
2. The plastic limit of soil decreases with increase in percentage of shredded rubber tyre which indicates that the fine-grained soil can be remolded without cracking Thus the soil becomes more stable and suitable to support loads.
3. The specific gravity of soil increases with increase in percentage of shredded rubber tyre. Higher value of specific gravity gives more strength for roads and foundations.

Overall it can be concluded that soil - rubber tyre mixture can be considered as a good ground improvement technique especially in engineering projects on weak soils where it can act as a substitute to deep/raft foundations, reducing the cost as well as energy.

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