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Enhancing the Soil Stability using Shredded Crumbed Rubber and Lime

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Abstract: The research described herein is an investigation into the engineering properties necessary for use of scrap tires in construction replacing, supplementing, and improving common earthen materials of construction. The shredded crumbed rubber and lime is mixed in various proportions on clay and various properties of soil mixtures are found. The addition of shredded crumbed rubber with lime shows improvement in density and packing in clay, hence its beneficial to use for sub base course.
Keywords: Shredded crumb rubber, Lime, Light weight Proctor test, Heavy weight proctor test, CBR Value, Dry Density.

I. INTRODUCTION

Disposal of discarded waste tires is one of the primus problem faced by the industries and government of many countries because it has a momentous share in the solid waste. About 1.5 billion tyres have been produced in a tear throughout the world and per annum almost 1000 million tires reach the end of their useful life. In India, a phenomenal increase in the number of automobiles has been noticed. In year 2010-11 the total production of tires was 124.3 million and became 146.1 million in the year 2014-15 (ATMA, 2015) Geotechnical engineers around the world are in search of new alternative materials which are required both for cost effective solutions for ground improvements and for conservation of scarce natural resources. The Industrialization and urbanization have been the two worldwide phenomenon in the present century. The major ill effect of industrial wastes (such as incineration ash, plastic waste, rice husk-ash, waste rubber tires etc.) and the problems related to their safe disposal and management. The safe and profitable disposal of these wastes is one of the greatest challenges before the industries.

The use of waste tires as a fuel is now prohibited by Indian government since 2006 due to its environmental impact. The common practice used for disposal of the waste tire such as stock piles, and fills and burning are considered as a big danger to the health of humans and ecological systems. The stockpiling provides breeding sites for mosquitoes and rodent, whereas heaving of the ground has been faced with landfills disposal of waste tires. The poisonous gases released by the burning of waste tires caused hazards to the population living nearby area.

Therefore, timely action regarding the safe disposal of waste tire is necessary, keeping in view the environmental problems and health hazards associated with it, one of the common and feasible ways to utilize these waste products is to explore their uses in the construction of roads, highways, embankments and a fill material. Tire waste can be used light weight material in the form of powder, chips, shredded and effective in protecting the environment and conserving natural resources.

Now a days construction is also being carried out on marginal sites having extremely poor ground conditions like soft clays that were earlier considered unsuitable due to their poor strength and high compressibility. Such soils, when loaded cause excessive settlements and early failure of structures.

Apart from the environmental benefits of recycling waste tires also has tremendous potential of generating wealth. To address the above concerns shredded crumb rubber is an additive to improve the industry. The use of discarded waste tires as an engineering material is gaining popularity among civil engineering fraternity due to its low density, high strength, resilience and high frictional strength, which are essential from the geotechnical engineering perspective.

In this fast developing world it seems impossible to impose restrictions on the design requirements. The very purpose of the structure to be built on such soil is not served. Secondly it is uneconomical to remove the material at site when huge quantities are involved. Rather it is difficult to find the superior material when required in quantities. So replacement of site material is only limited to when quantities involved are not much. Sometimes the feasibility of the whole project involving the huge amount of soil fill becomes jeopardized because of uneconomical import of soil from other sources.

So we are left with third alternative of improving the engineering behaviour of the available soil. Altering the properties of the soil has vast scope for meeting the designed requirements.

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II. LITERATURE REVIEW

In the present environmental and economic ambiance high pressure are laid on the engineers to identify suitable methods wherever possible to reuse any locally available waste materials in order to minimize the costs of a project and its impacts on the environment. In ground improvement methods, waste materials are also used to improve geotechnical properties of soil. Disposal of tires wastes are essential since it cause various hazardous to the environment. The benefits of reusing scrap tires are particularly enhance if they can be used to replace (fully or partially) scarce and valuable virgin construction materials which are non-renewable.

Baykal et al. (1992) mixed clay with used tire obtained from retarding industry and hydraulic conductivity tests were conducted using water gasoline as permeates. The strength of soil tire powder decreases once the rubber content exceeds 30% in the mixture because soil tire chip mixture behaves less like reinforced soil and more like a fuse chip mass with sand inclusion.

foose (1996) falling head permeability test were conducted on rubber mixed soil samples and it was observed that when water permitted through samples a slight increase in hydraulic conductivity was observed

lee et it (1999) also determined the shear strength and stress-strain relationship of tire chip and a mixture of sand and tire chips. They found out the stiffness and strength properties for chips shreds and rubber sand mixture.

Papp et el (1997) conducted research shredded scrap tires blended with sub base soils under flexible pavements. Resilient modulus (Mr) testing was used to determine the plastic and elastic strains tests were conducted on cohessionless soil blended with varying amounts of shredded tire chips. Blend ratios ranged from 0.1 to 0.5 tire chips to soil by dry weight. The performance of the shredded tire blends was compared to that of the naturally occurring virgin soil used in sub base applications in New Jersey. He concluded that physically mixing tire chips with the soil did not present any problems except when excessive steel wires were protruding from the chips. The addition of the tire chips to the soil reduced both density and strength of the soil. The 50mm(1.96 inch) tire chips were most economical and had the least negative strength impact.

Rao and Dutta (2001) conducted studies on sand mixed with rubber chips. Compressibility tests and triaxial tests were conducted. The stress strain relations and strength parameters were studied. it was found that the value of internal friction and effective cohesion of sand increased with increase in percentage of rubber up to 15%.

Cabalar, (2011) blended GTR with sands from two geologic formation, Leighton Buzzard Sand (LBS) and Cyan Sand (CS). These sands were selected for their differences in structure and engineering properties LBS is coarse with sub angular particles, and CS is fine with angular particles. The rubber pieces size was not listed but the particles were described as "flaky." Rubber was blended with each type of sand at 5, 10, 20, and 50% by weight. Each blend was subjected to direct shear tests and observed that the shear stress and internal friction angle of the two mixtures decreased at about 10% rubber concentration and then levelled off. He concluded that the blends were useful as light weight embankment fill on weak foundation soils and retaining wall backfill material since the sand rubber mixtures were significantly lighter than 100% sand mixtures.

Sompote Youwai (1992) performed triaxial tests on compacted shredded rubber tyre-sand mixtures. The tests were carried out with different mixing ratios of shredded rubber tyres and sand. With an increasing proportion of sand in the mixture, the density, unit weight and shear strength of the mixture increased, but the compressibility decreased. The dilatancy characteristics of shredded rubber tyres mixed sand were relatively similar to a cohesionless material.

III. MATERIAL USED

The materials used in research work are as follows:

1) *Soil:* In this study, clayey sub-grade soil is used. Locally available clayey soil was collected from the fields nearby the my research centre (Shri Shankaracharya Technical Campus, SSGI) Junwani, Durg at a depth of 0.7m below the ground surface by using technique of disturbed sampling the sample is collected and further the sample is thoroughly hand sorted to eliminate the vegetative matters and pebbles before taken in to laboratories. The sample is then stored in a dry place in wooden box. The soil Sample used for further work is then carried out
2) *Shredded Crumb Rubber:* Scrap tyres are undesired urban waste, the volume of which is increasing every year. One of the possible use of this waste is to use shredded tyres alone or mixed with soil as a lightweight backfill. The conventional and large triaxial tests on the crumb rubber with and without Lime mixtures have been conducted. The tests were carried out at different mixing ratios of crumb rubber tyre and Lime. The shredded crumb rubber passing from 4.75 mm IS sieve is used.
3) *Lime:* Lime is used along with the Shredded shredded crumb rubber in order to enhance the engineering properties of soil. In this study lime is used from the locally available market, it is easily available in market in powder form, so it can be easy to mix with soil. The lime is used in very little proportion with Shredded shreded crumb rubber.

IV. METHODOLOGY

A. Mix Proportioning

Clayey Soil, crumb rubber and lime is to be mixed thoroughly to have a uniform and homogenous mixture. Sample will be prepared using different combination of crumb rubber, lime and parent soil and different tests will be conducted on the prepared samples and result will be compared with the original clay sample. The shredded crumb rubber passes from 1 mm IS sieve is used so it can be easily mixed with clay and lime.

Table 4.1: Various proportions of sample used

Sample	Soil (%)	Shredded crumb rubber (%)	Lime (%)
A	100	0	0
B	93	5	2
C	86	10	4
D	79	15	6

The following tests were conducted:-

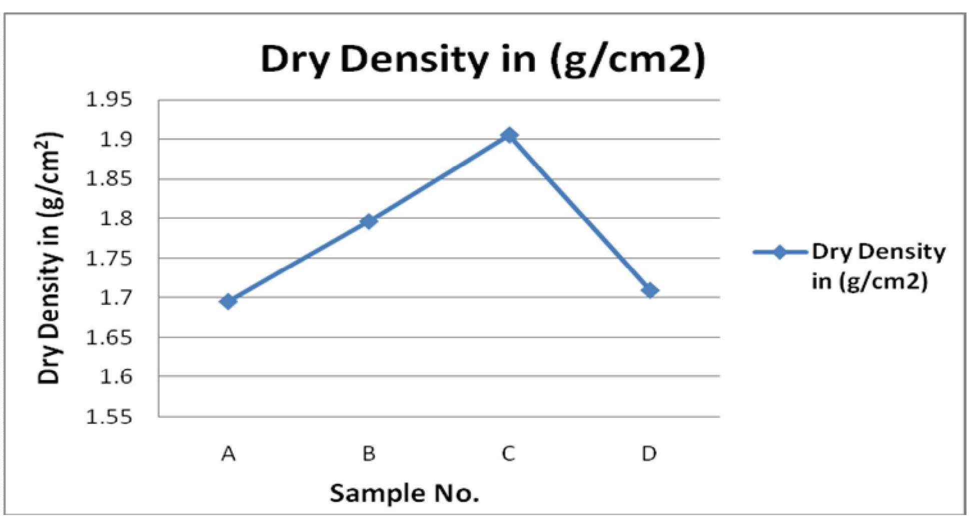
1) Grain Size
2) Liquid Limit and Plastic Limit Test
3) Proctor Test (Light weight and Heavy weight test)
4) California bearing ratio test (CBR Test)
5) Specific gravity test

V. RESULTS

In this chapter, the experimental results are presented and discussed.

1) The Specific Gravity of soil sample taken (G) = 2.5.
2) Dry Density by Light weight Proctor test

Sample No.	Dry Density in (g/cm^2)	% OMC (Optimum Moisture Content)
A	1.696	12.3
B	1.797	11.8
C	1.906	11.7
D	1.710	11.4



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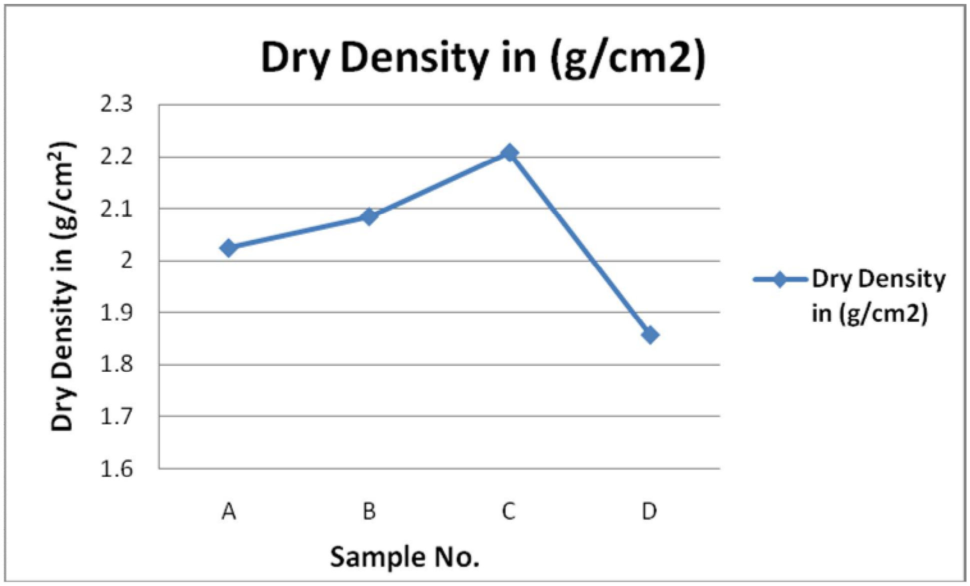
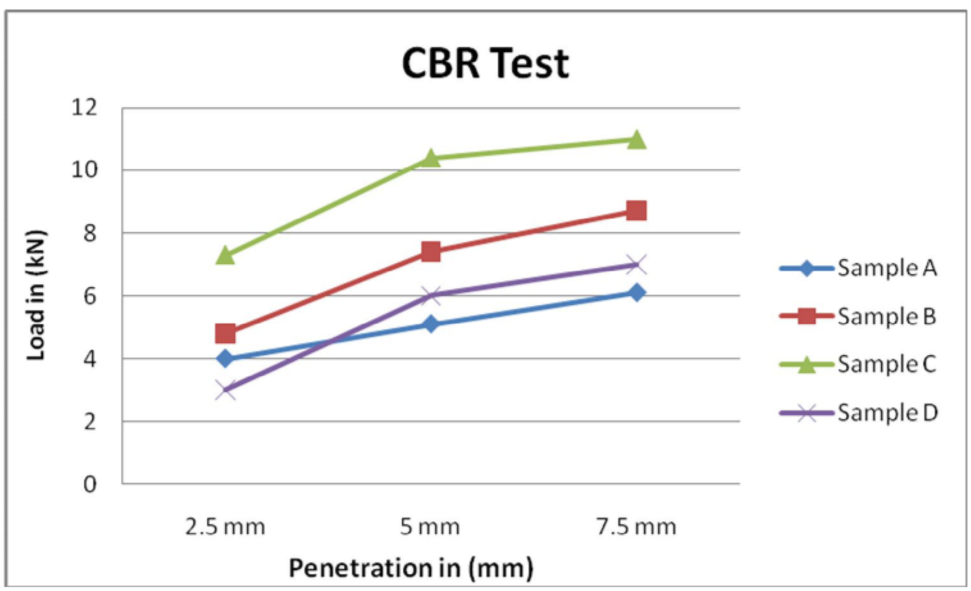
3) Dry Density by Heavy weight Proctor test

Sample No.	Dry Density in (g/cm^2)	% OMC (Optimum Moisture Content)
A	2.024	8.4
B	2.084	8.3
C	2.207	8.1
D	1.857	7.9



4) California bearing Ratio (CBR) Test for values

Penetration in (mm)	Load (kN)			
	Sample A	Sample B	Sample C	Sample D
2.5 mm	4.0	4.8	7.3	3.0
5 mm	5.1	7.4	10.4	6.0
7.5 mm	6.1	8.7	11.0	7.0



VI. CONCLUSIONS

A. The study shows that the maximum dry density of soil is obtained for 10% percentage of shredded crumb rubber and 4% of lime (Sample C), further increases soil-crumb rubber-lime mixture ratio may decreases maximum dry density.

B. Where the weight of the fill is a critical factor, soil-crumb rubber-lime mixture may be used to produce a light weight, highly porous fill with acceptable strength and deformation characteristics.

C. Significant increase in CBR value of shredded crumb rubber-lime mixture is observed at 10% shredded crumb rubber and 4% of Lime mixed with soil which may be used for sub base course.

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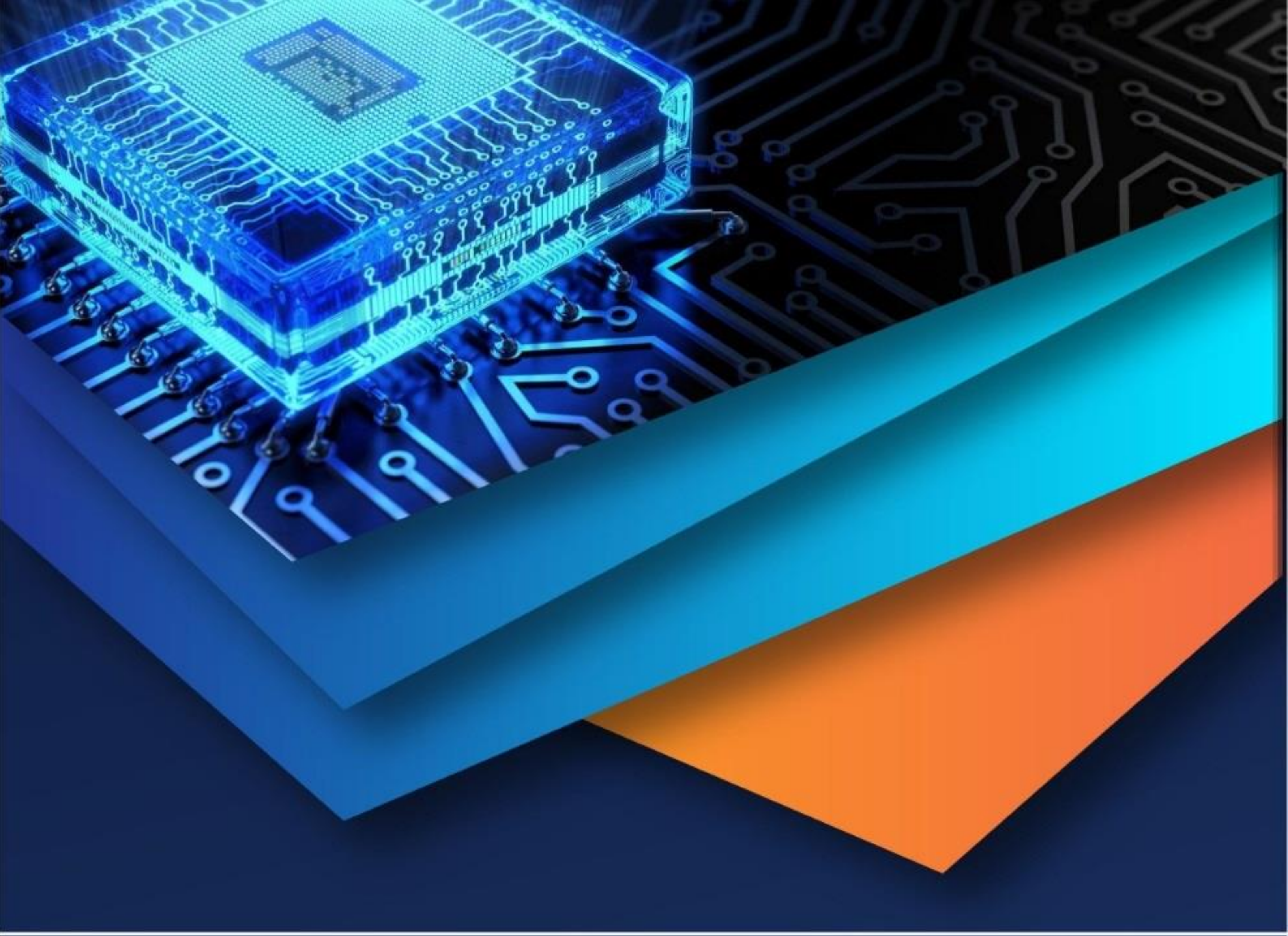

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