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SOIL STABILIZATION USING WASTE SHREDDED RUBBER TYRE CHIPS WITH ADDITION OF CEMENT

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ABSTRACT

Soil Stabilization is that the development that deals with modifying the properties of soil (Index & Engineering) to boost its performance so that stabilization can be effectively getting used. For a range of engineering works either in its natural kind or during a processed kind. Eventually all structures rest on soil foundation wherever the most objective is to extend the strength or stability of soil and to cut back the development value. Shredded rubber tyre having sizes ranges from 5mm to 10mm (Width), 10mm to 15mm (Length) and a couple of to 3mm in thickness and therefore the steel belting was removed are used extensively. Added amount of rubber tyre varied in proportions of 4%, 6%, 8% and 10% as well as 2% and 4% of cement. Use of shredded rubber tyres in geotechnical engineering for enhancing the soil properties has received great attention within its recent times. It presents the investigation of behaviour of pavement subgrade soil stabilized with shredded rubber tyre chips with addition of cement. The strength is also evaluated based on unconfined compressive strength and the penetration resistance in terms of California Bearing Ratio (CBR) test for the samples compacted at maximum proctor density for optimum dosages of cement and shredded rubber tyre chips pieces in the soil. The results showed that the soil can be effectively stabilized to be used as a highway material to a great extent by making use of waste shredded rubber tyre pieces that would otherwise degrade the environment.

Keywords: — Stabilization, shredded rubber tyre chips, California Bearing Ratio (CBR) test, maximum proctor density.

1.INTRODUCTION

1.1 General: -

The soil often is weak and has no enough stabilization found in heavy loading. The aim of the study is to use the waste material for stabilization of soil in order to reduce the environmental impact. Several reinforcement methods are available for stabilization of soils. Scrap tyre generations are always on the increasing trend everywhere in the world. Majority of them (Rubber tyres) end up in the already congested landfill or becoming mosquito breeding places. Worst when they are burned. The aims of studying the appropriate behavior of shredded rubber tyres for its use in pavement engineering, i.e. to stabilized the subgrade of the pavements. It discusses about CBR value of soil-tyre chips mixture and the results are presented.

Many civil engineering structures such as soil underlying structures may fail due to failure of soil for e.g. construction of buildings, dams, bridges, roads etc. Out of these one of the major problems which country faces are failures of transportation system. An efficient transport system should be a pre- requisite for sustained economic development. It is not only the key infrastructural input for the growth process for any economy but also plays a significant role in promoting national integration, which is particularly important in a very large country like India thus roadways are essential component in nation building. Monsoons season is rich in country like India and we know moisture becomes a huge problem in roads. Admission of water in monsoons season weakens the roads soil base. For soil like black cotton soil these climatic changes are responsible for its swelling as well as for shrinkage. Addition of some nano chemicals to soil in an optimum quantity can be proved beneficial to the problem discussed above.

India is the seventh largest country in the world, whenever we see in the terms of geographic area. India is the large country (geographical area of 3, 287, 240 sq Km.) and huge population of India (140 million approximate) it is second ranking in word, the vast network of structures and roads are required (Singh and Mittal, 2014). The land available for any construction is very less because of increasing urbanization and modernizations. Everywhere land is being utilized for various structures from an ordinary house, from bridges to airports and from village road to highways or expressway. Various types of soils are available in India like alluvial soils, black cotton soils, laterites soils, mountain soils, desert soils, red soils. Soil is the upper most part of earth and its cheapest and readily available construction material, has been popular with the civil engineers, even though its being poor properties. Soil is generally four basic types (such as): Gravel, sand, Clay & Silt. It's normally has low tensile and shear strength and its characteristics may depend

strongly on the geographical conditions. (e. g. Dry, wet, hilly etc.) The engineering properties of the soil such as shear strength, bearing capacity, compressibility.

A full road network system in developing in India is not easy (very difficult) due to limited finances available to build up roads (Nithin S. & Sayida M. K.). The construction of road imposes a heavy pressure or heavy load on limited resources like suitable earth, stone aggregates binders etc. For sustainable development use of locally available materials, waste materials should be encouraged in order to save the natural resources for future generation.

1.2Problems associated with cement stabilization

The contribution of cement hydration in the development of shrinkage cracks is less as compared to water loss. Nevertheless, excessive amount of cement aggravates the development of cracks in two ways:

- Higher amount of cement in the mix causes greater water consumption during hydration which in turn increases the drying shrinkage;
- Increased amount of cement increases the rigidity and tensile strength of the treated materials. As a result, widely spaced wide cracks are developed in these location.
- The wider spacing of the cracks is attributed to the higher tensile strength and the wider width of individual cracks is due to the distribution of total shrinkage of the material within smaller number of the widely spaced cracks.

Despite the many benefits, there are problems also associated with cement stabilized materials that entail due considerations. The main problems that will have pronounced a negative effect if not controlled are cracking and carbonation. These problems are happened in the compacted stabilized layer after the construction. The most common type of crack in cement-stabilized base is shrinkage crack. Shrinkage cracks are related to loss of water, cement content, density of compacted material, method of compaction, and pre-treatment moisture content of the material to be stabilized. Cement treated materials begin to lose their moisture through an evaporation immediately after they are placed if proper curing is not exercised. The loss of moisture then will lead to the drying and subsequent development of shrinkage cracks.

2.MATERIAL USED

2.1Black Cotton soil: -

In this study the shredded rubber chips used are of length between 6.7 mm and 19 mm. These shredded rubber tyre chips have been obtained from various tyres rethreading centres. These chips have a thickness of at least 2 to 3 mm, having specific gravity of 1.18. These rubber chips are sieved through 4.75 mm IS sieve, as to eliminate the smaller shredded rubber tyre pieces. These rubber tyre chips do not possess steel wires or any form of reinforcement. Shredded tyre chips material was obtained from the waste generated from tyre re-threading industries. The shredded tyre material used is of size 10mm to 15 mm in length. The shreds have a thickness 2mm to 3mm. Soil Stabilization Using Waste Shredded Rubber Tyre ranging from 2 to 3 mm and they don't contain any steel wire or nylon fibres. Specific gravity of tyre shreds obtained with a pycnometer test ranges from 0.90 to 1.12.

S.No.	Characteristics	Value
1.	Atterberg's limits: a) Liquid limit (%) b) Plastic limit (%) c) Plasticity index(%)	 42 26 12
2.	d) Colour	Black
3.	e) IS classification	CI
4.	f) Standard Proctor Compaction test result: Optimum moisture content (%) Maximum dry density(gm/cc)	 14 1.84
1.	Soaked CBR(%)	1.86
2.	Unsoaked CBR(%)	2.42

Table 1 Soil Characteristics

2.2Cement: -

Cement is one of the most popular soil stabilizers because it is readily available and generally can be applied to a wide ranges of materials. It is considered to have an advanced property. The unit price of cement varies greatly depending on the distribution network and the proximity of the cement manufacturing plant but in many parts of the world is one of the cheapest binders are available**.**

Portland cement used either to modify and improve the quality of the soil or to transform the soil into a cemented mass with increased strength and durability. An Ordinary Portland Cement (OPC) of 53 grade has been used for treatment of the selected soil in order to modify its properties such as unconfined compressive strength (UCS) and California bearing (CBR) ratio.

Sl. No	Physical properties	Range
1	Fineness (m^2/kg)	330
2	Standard Consistency (%)	30.5
3	Initial setting time(min.)	150
4	Final setting time(minutes)	225

Table 2 Physical requirements of the OPC 53 grade cement

2.3Shredded tyre rubber: -

Shredded tyre material was obtained from the waste generated. The shredded tyre material used is of size 10mm to 15 mm in length, 5mm to 10mm in width. The shreds have a thickness of 2mm and also does not contain any types of fibre & any any type of steel wire in it.

Processed tyre materials are often an irregular in shape. Most processed material, like shreds and chips, are in disc-shaped. The processed shredded rubber tyre was may not be of regular shape and size. The dimension of the rubber chips was presented as nominal size in this study. Generally, tyre chips having size of 10mm to 20mm and 2mm to 3mm thick after removing steel belting are used extensively. The shredded tyre material used which are free from steel wire or nylon fibres.

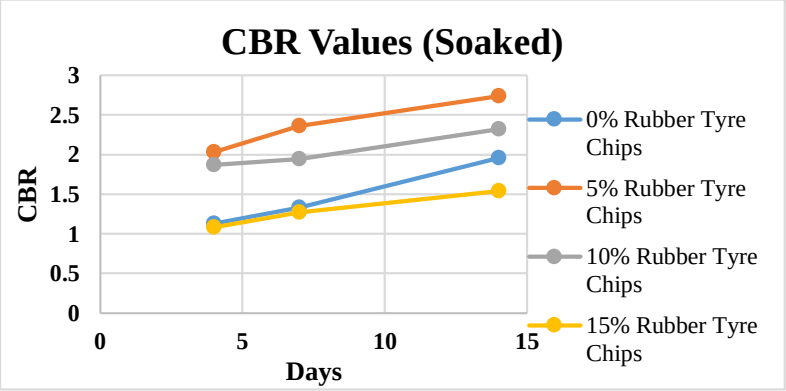
3.EXPERIMENTAL ANALYSIS

3.1Stabilizer: Rubber Tyre Chips

Next, we take rubber tyre chips as soil stabilizer and mix it with the black cotton soil in different percentages (0%,5%,10%,15%) and perform the test to check the CBR values for both of conditions i.e. soaked and unsoaked.

S.No.	Rubber Tyre Chips(%)	CBR Value in 4 days curing period(%)	CBR Value in 7 days curing period(%)	CBR Value in 14 days curing period(%)
1	Soil+0%RTC	1.13	1.33	1.96
2	Soil+5%RTC	2.03	2.36	2.74
3	Soil+10%RTC	1.87	1.94	2.32
4	Soil+15%RTC	1.08	1.27	1.54

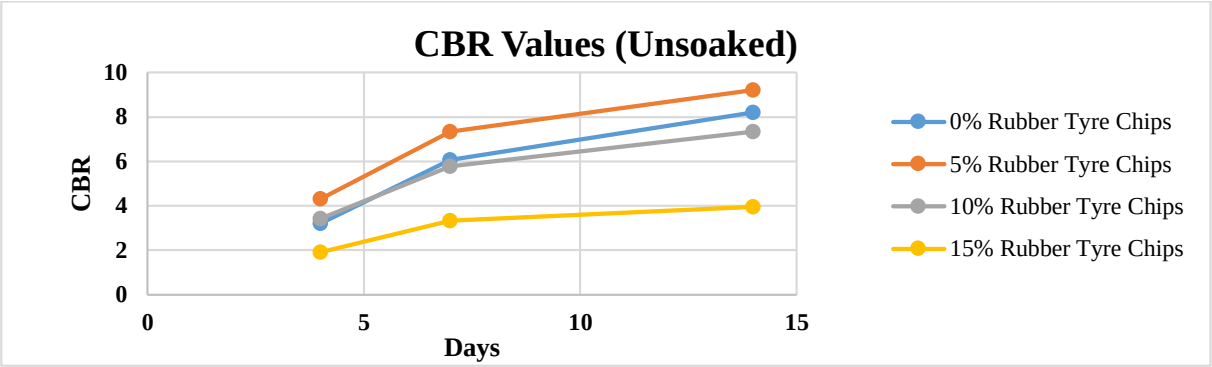
Table 3.1: CBR Test Results(Soaked) of Rubber Tyre Chips with soil



Graph 3.1: CBR Test Results(Soaked) of Rubber Tyre Chips with soil

S.No.	Rubber Tyre Chips(%)	CBR Value in 4 days curing period(%)	CBR Value in 7 days curing period(%)	CBR Value in 14 days curing period(%)
1	Soil+0%RTC	3.22	6.08	8.21
2	Soil+5%RTC	4.31	7.34	9.21
3	Soil+10%RTC	3.42	5.78	7.34
4	Soil+15%RTC	1.92	3.32	3.96

Table 3.2 : CBR Test Results(Unsoaked) of Rubber Tyre Chips with soil



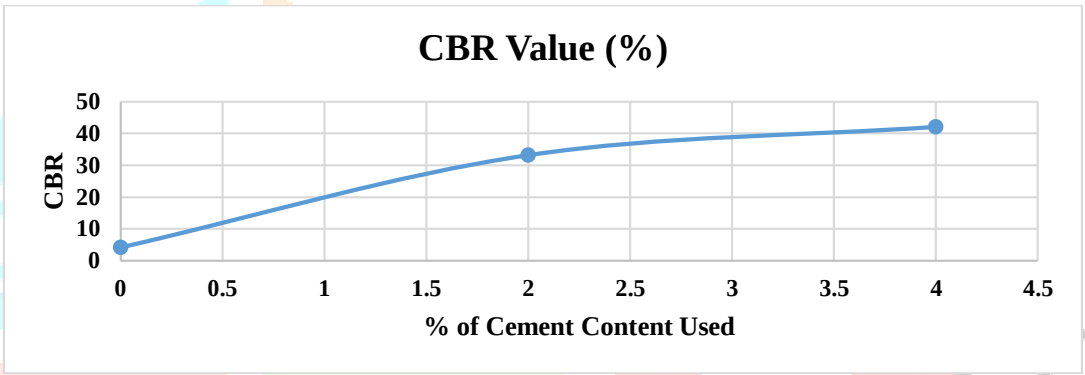
Graph 3.2: CBR Test Results(Unsoaked) of Rubber Tyre Chips with soil

3.2 Stabilizer: Cement

Firstly, we take Cement as soil stabilizer and mix it with the soil in different percentages (0%,2% and 4%) and perform the test to chec the CBR values. Different- Different CBR values as shown below in table: -

S.No.	Cement (%)	CBR Value (%)
1	Soil+0%	4.2
2	Soil+2%	33.14
3	Soil+4%	42.02

Table 3.3: CBR Test Results of Cement with soil



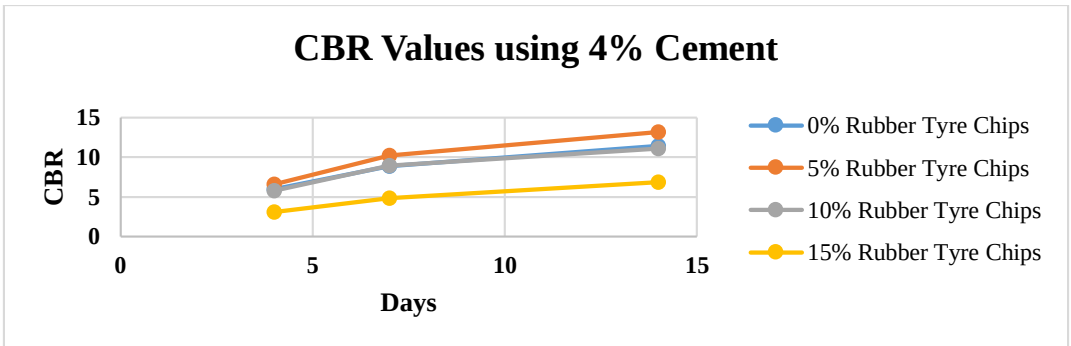
Graph 3.3: CBR Test Results of Cement with soil

3.3 Soil, Cement and Rubber Tyre Chips CBR values: -

Next combination is Soil, Cement+ RTC. Perform the test to check the CBR values with different percentage and in different days as well as for both the conditions i.e. soaked and unsoaked.

Rubber Content(%)	Black Cotton Soil					
	2%Cement			4%Cement		
	Curing Period in Days			Curing Period in Days		
	4 days	7 days	14 days	4 days	7 days	14 days
0	2.58	2.94	4.24	5.98	8.9	11.4
5	3.78	4.08	4.92	6.58	10.21	13.17
10	2.64	2.84	3.54	5.76	8.92	11.08
15	1.96	2.28	3.06	3.08	4.86	6.83

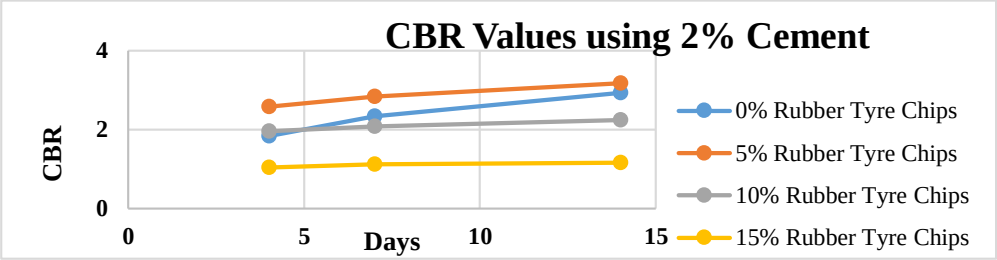
Table 3.4: CBR test results of Black cotton soil with Cement (Unsoaked) + RTC



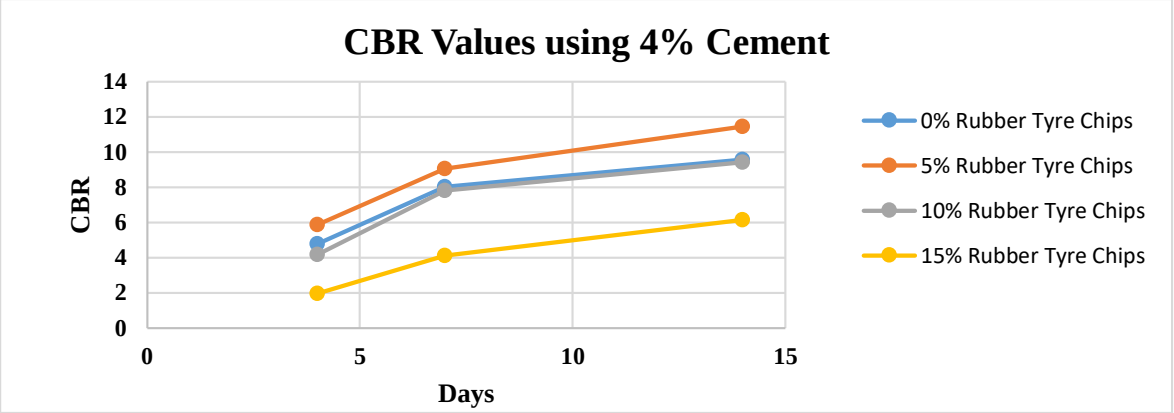
Graph 3.4: CBR value after adding Cement+ RTC

Rubber Content(%)	Black Cotton Soil					
	2%Cement			4%Cement		
	Curing Period in Days			Curing Period in Days		
	4 days	7 days	14 days	4 days	7 days	14 days
0	1.84	2.34	2.94	4.78	8.04	9.56
5	2.58	2.84	3.18	5.86	9.05	11.46
10	1.96	2.08	2.24	4.18	7.82	9.42
15	1.04	1.12	1.16	1.96	4.12	6.14

Table 3.4: CBR test results of Black cotton soil with Cement (Soaked)+ RTC



Graph 3.4(a): CBR test results of Black cotton soil with Cement (Unsoaked) + RTC

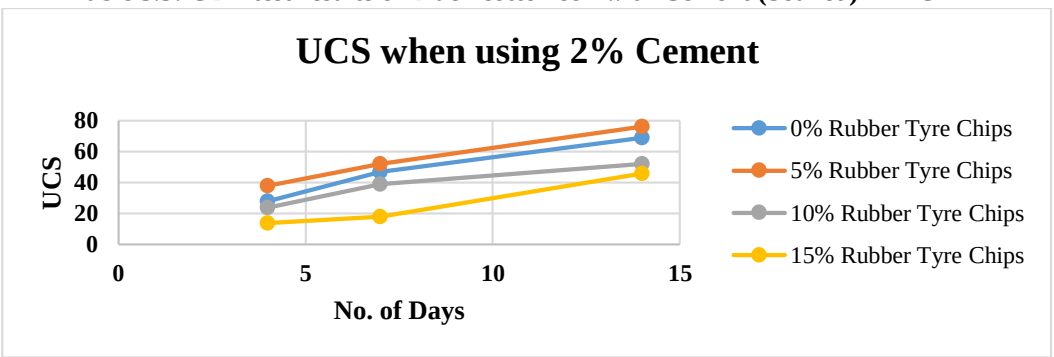


Graph 3.4(b): CBR test results of Black cotton soil with Cement (Soaked)+ RTC

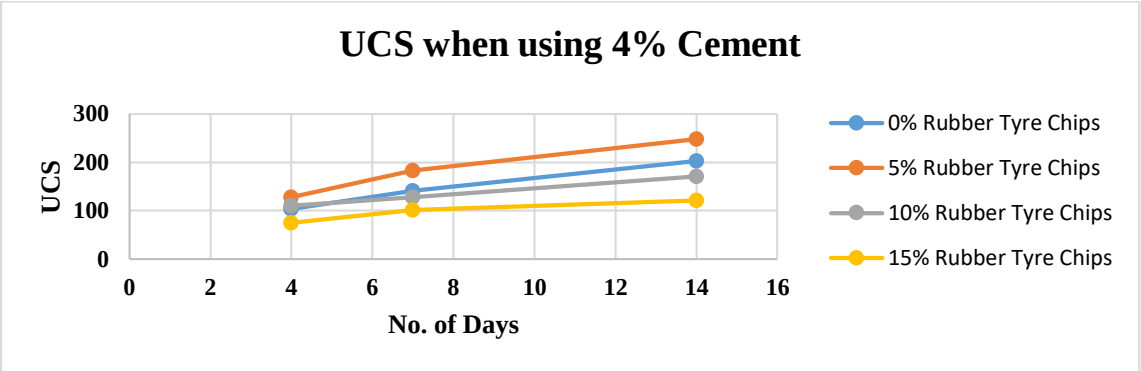
3.5 Soil, Cement and Rubber Tyre Chips Unconfined Compressive Strength Test values: -

Rubber Content(%)	Black Cotton Soil					
	2%Cement			4%Cement		
	Curing Period in Days			Curing Period in Days		
	4 days	7 days	14 days	4 days	7 days	14 days
0	28	47	69	104	141	203
5	38	52	76	128	183	248
10	24	39	52	110	128	171
15	14	18	46	75	101	121

Table 3.5: CBR test results of Black cotton soil with Cement (Soaked)+ RTC



Graph 3.5(a): Soil, Cement (2%) and RTC Unconfined Compressive Strength Test values



Graph 3.5(b): Soil, Cement (4%) and RTC Unconfined Compressive Strength Test values

4.RESULT ANALYSIS AND DISCUSSION

It has been observed that cement can tremendously increase the CBR value of black cotton soil more proficiently as compared to Rubber tyre chips. So if we combine them the value of CBR as well as UCS will also increase. Unconfined Compressive Strength Tests and California bearing ratio tests are conducted for black cotton soil and with 2% and 4% cement with the varying rubber percentage i.e. 0%,5%,10% and 15% and the results were noted and compared as shown in the tables and figs.as shown above.

The given below typical graphs of unconfined compressive strength show variation of unconfined compressive strength and California bearing ratio test shows the variation of California bearing ratio both soaked and unsoaked for curing period of 4, 7 and 14 days with the addition of 2% and 4%cement.

It is seen that the CBR as well as UCS is increasing till 5% after that it is decreasing continuously. So we can use 5% of Rubber tyre chips.

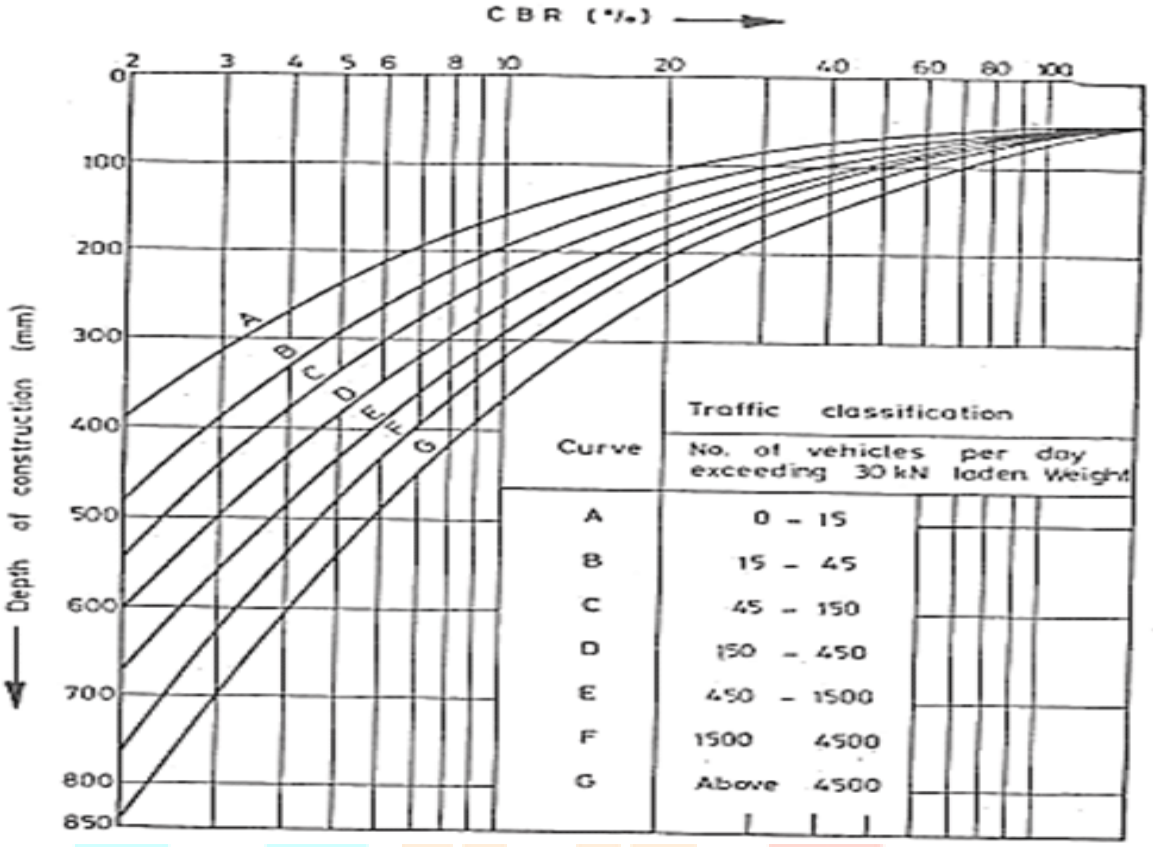
5.CONCLUSION

1) The unconfined compressive strength and California bearing ratio increases with the increase in cement content at an optimum Rubber tyre chips content of 5%.
2) The unconfined compressive strength has increased from 15KPa to 74Kpa for 2% cement and 246Kpa for 4% cement for black cotton soil.
3) Deep foundations and raft foundations for structures on soil with low bearing capacity can be replaced by shallow foundations with soil stabilized by shredded rubber tyre waste.
4) California bearing ratio (soaked) has increased from 5.86% to 11.46% for 4% cement which reduces pavement thickness by 64.51% for black cotton soil.
5) Increases in CBR value significantly reduce the total thickness of the pavement and hence the total cost involved in the project.
6) Shredded rubber fiber can be considered as a good reinforcement material.
7) This modification can be successfully used in areas where the soils to improve the bearing capacity while designing the foundation.
8) The stabilized soil can be used to reduce the overall thickness of pavement layer, which may reduce the cost of road construction.

For further investigation, laboratory tests can be carried in the same way with other stabilizing agents and shredded rubber tyre.

6.Scope for Future Investigation

Design of flexible pavement for black cotton soil
Design of flexible pavement for black cotton soil without stabilization,
Number of commercial vehicles per day = 450
Applicable CBR design curve = E
Design CBR (soaked) for subgrade soil =1.86 %
Hence, the pavement thickness (from Pavement thickness design chart) = 675 mm
Design of flexible pavement for black cotton soil with stabilization,
Number of commercial vehicles per day = 450
Applicable CBR design curve = E
Design CBR (soaked) for subgrade soil =11.46 %
Hence, the pavement thickness (from Pavement thickness design chart) = 275 mm Total reduction in pavement thickness 675 -275 = 400mm
Percentage reduction in pavement thickness = 64.51%



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