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An Experimental Study on Stabilization of Soil by using Shredded Rubber Tyre

S.D. Farhana Tabasum[1], M. Laharipriya[2], V. Saranya[3], Y. Jyothsna[4], D. Dharani[5], M. Vijaya Lakshmi[6]

[1]Assistant Professor, Department of Civil Engineering, Sree Venkateshwara college of Engineering, Kodavaluru(V&M), SPSR Nellore, Andhra Pradesh, India.
[2,3,4,5,6]Students, Department of Civil Engineering, Sree Venkateshwara college of Engineering, Kodavaluru(V&M), SPSR Nellore, Andhra Pradesh, India.

Abstract
Soil properties play very important role in construction. Sometime the properties of soil are not favourable for construction and we used some method to improve properties of soil called soil stabilization. Improvement of load bearing capacity of the soil may be undertaken by a variety of ground improvement techniques. In this project we are using shredded rubber tyres to improve properties of soil. With ongoing rise in use of motor vehicles hundreds of millions of tyres discarded each year throughout the world. Use of tyres in geotechnical engineering for improvement of bearing capacity of black cotton soil has received great attention in recent times. Shredded rubber tyres with different percentages (4%,6%,8%,10%) of tyres by weight of soil sample for the experiment work. The investigation has been focused on the strength behavior of soil reinforced with randomly included shredded rubber fiber. The main objective is to increase the strength or stability of soil and to reduce the construction cost by using local available materials. The low strength and high compressible soft soils were found to improve by addition of shredded rubber. The samples were subjected to California bearing ratio and standard proctor test.

Keywords: Soil Stabilization, Black cotton soil, shredded rubber tyre, CBR.

1.0 INTRODUCTION

Soil is very important thing for construction. Soil in site should be such that it can bear the load even in critical situation. But some time soil is good in normal condition. but in adverse condition soil is not capable of bearing the load, it fails in shear or another type of failure occur. To avoid this type of failure, we should investigate the soil properly, in normal condition or in adverse condition also. 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. so we use soil stabilization, we improve the soil properties by mechanical and chemical action, In this paper shredded rubber tyre of different percentages and used to find the effect of shredded rubber tyre on California bearing test.

1.1 Objectives Of Soil Stabilization

There are different objectives for this, which include:

- Substituting poor-quality soils with aggregates with better engineering properties.

- Strengthening of the soil, and its bearing capacity.
- Waterproofing is used to preserve natural or man-made buildings.
- To encourage the use of waste geomaterials in building construction.
- To improve permeability characteristics.

1.2 Need for using the shredeed rubber tyre as soil stabilizer

Using shredded rubber tires as a soil stabilizer has several potential benefits, including:

- **Increased stability:** The shredded rubber tire can be mixed with soil to improve its stability and reduce erosion. The rubber particles interlock and provide additional strength and stability to the soil.
- **Reduced compaction:** Compaction of soil can be a major problem, particularly in areas where heavy machinery is used. The use of shredded rubber tires can help reduce soil compaction and improve soil porosity.

1.3 Distribution of black cotton soil in india:

- Black cotton soil, also known as regur soil, is mainly found in the central and southern parts of India. Some of the states with a significant distribution of black cotton soil are:
- **Maharashtra:** The Vidarbha region of Maharashtra is known for its black cotton soil. Cities like Nagpur, Amravati, and Akola have large areas covered with this type of soil.
- **Andhra Pradesh:** The Rayalaseema region in Andhra Pradesh has large deposits of black cotton soil. Cities like Kadapa, Kurnool, and Anantapur have significant areas covered with this type of soil.

1.4 Principles of soil stabilization

- Deciding the properties of soil which need to be altered to get the design value and choose the effective and economical method for stabilization.
- Evaluating the soil properties of the area is under consideration.
- Designing the stabilized soil mix sample and testing it in the lab for intended stability and durability values.

1.5 Advantages and needs

Soil stabilization is the process of improving the physical properties of soil to make it more stable and suitable for construction, farming, or other uses.
Here are some of the advantages and needs of soil stabilization:

- **Improved soil strength:** Soil stabilization can increase the strength and stability of soil,making it better able to support heavy loads and prevent soil erosion.
- **Reduced soil settlement:** Stabilized soil can also reduce soil settlement, which can prevent damage to buildings, roads, and other structures built on top of the soil.
- **Enhanced soil durability:** Soil stabilization can improve the durability of soil, making it more resistant to wear and tear, weathering, and other forms of damage.

2.0 Literature Review

Several authors have reported various successful improvement techniques of soil using shredded rubber tyre.

Soil stabilization means alteration of soil properties to meet the specified engineering requirements. Disposal of tyres wastes are essential since it cause various hazardous to the environment. With the same intention literature review is undertaken on utilization of solid waste materials for stabilization of soil and their performance.

Jagtar singh and prof. Vinod kumar sonthwal In this paper times. This paper presents the effect on the behaviour of pavement sub grade when we used shredded rubber tyre to improve properties of soil. Shredded rubber tyres with different sizes (10mm, 20mm, 30mm) in width and (20mm 40mm 60mm) in length are used for Experimental work. The percentage used is (5% 10% 15%) for the experimental work The optimum moisture content is found to increase with increase in percentage of shredded tyre, because shredded tyres have some water absorption value. It. The maximum dry density of soil decreases with increase in percentage of soil. This is due to the light weight nature of Tyre waste.

Ghatge sandeep hambirao,Dr.P.G.Rakaddi the Present investigation, shredded rubber from waste has been chosen as the reinforcement three different of fibre content, i.e., 5% 10% and 15% by weight of soil. The investigation has been focused on the strength behaviour of soil reinforced with randomly included shredded rubber fibre. The samples were subjected to California bearing ratio and Unconfined compression tests. The tests have clearly shown a significant improvement in the shear strength and Bearing capacity parameters of the studied soil.

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Shredded rubber tyres with different sizes (10mm 20mm.30mm) in width and (20mm,40mm,60mm) in length are used for experimental work. The percentage used is (1%.2%,11%) for the experimental work. Use of shredded rubber tyres in geotechnical engineering for Enhancing the soil properties, has received great attention in the Recent times. This paper presents the effect on the behaviour of Pavement subgrade when pavement subgrade soil is stabilized with shredded rubber tyre. It is found from the investigation that the optimum value of shredded rubber tyre is 1%.and size is 10mm 20mm.it improve the value of UCS by 7.83% than in Comparison of virgin soil.

- The maximum dry density of soil decreases with Increase in percentage of soil. This is due to the light Weight nature of tyre waste.
- The optimum moisture content is found to increase with increase in percentage of shredded tyre, because Shredded tyres have some water absorption value.

3.0 MATERIALS

Stabilization of black cotton soil is carried out by the addition of the shredded rubber in different proportions. Certain laboratory tests are conducted to the soil for obtaining the maximum dry density, optimum moisture content, California bearing ratio.

Materials used

The different materials used in this investigation are:

- Black cotton soil
- Shredded rubber tyre

Black cotton soil

The black cotton soil used in this study was collected from kothur village.Black cotton soil, also known as black soil or regur soil, is a type of soil that is commonly found in tropical regions, particularly in India. It is called "black cotton" because it is composed of fine-grained, dark-colored particles that have a texture similar to cotton.

Figure 1: Black cotton soil

3.1 Engineering properties of black cotton soil

Black cotton soil is a type of expansive clay soil that is commonly found in tropical and sub-tropical regions. It is known for its high plasticity, high swelling and shrinkage characteristics, and low bearing capacity. Some of the key engineering properties of black cotton soil are:

- Plasticity
- Swelling and Shrinkage
- Bearing Capacity
- Permeability
- Shear Strength

3.2Shredded rubber tyre

Shredded rubber tyres used in this study was collected from a factory near ayyappa gudi Centre at Nellore. Shredded rubber tyre refers to the process of cutting or shredding used or unwanted rubber tyres into small pieces or chips.

Shredded rubber is a term usually applied to recycled rubber from automotive and truck scrap tires. There are two major technologies for producing shredded rubber - ambient mechanical grinding and cryogenic grinding. Of the two processes, cryogenic process is more expensive but it produces smoother and smaller crumbs.

Shredded rubber is a term usually applied to recycled rubber from automotive and truck scrap Tires. During the recycling process steel and fluff is removed leaving tire rubber with a granular Consistency. Continued processing with a granulator and or cracker mill, possibly with the aid of Mechanical means, reduces the size of the particles Further. Now a day's Shredded rubber is often used as an additive in bituminous concrete mixes.

Figure 2: Showing Shredded Rubber Tyre

3.3 ADVANTAGES OF SHREDDED RUBBER

The following are the advantages of the crumb rubber

Environmentally friendly: Using shredded rubber tires as a material helps reduce waste in landfills and promotes recycling.

Durable: Shredded rubber tires have high elasticity and resilience, making them resistant to wear and tear. This makes them ideal for use in applications that require durability, such as in sports fields, playgrounds, and roads.

Cost-effective: Shredded rubber tires are a cost-effective alternative to traditional materials such as gravel or sand. They require less maintenance and have a longer lifespan.

Good shock absorption: Shredded rubber tires have excellent shock absorption qualities, making them ideal for use in playgrounds, sports fields, and running tracks.

Non-toxic: Shredded rubber tires are non-toxic and do not emit harmful fumes, making them a safe material to use in various applications**.**

3.4 Laboratory test for black cotton soil

The test conducted on soil are given below

A.Particle size distribution: Grain size analysis has been carried out as per 1.S. code of practice (1.S.2720 part IV; 1985).

The grain size analysis test is performed to determine the percentage of each size of grain that is contained within a soil sample, and the results of the test can be used to produce the grain size distribution curve. This information is used to classify the soil and to predict its behavior.

Read the diameters corresponding to 60%, 30%, 10% finer . calculate the coefficient of curvature (Cc) and uniformity coefficient (Cu) by using relations.

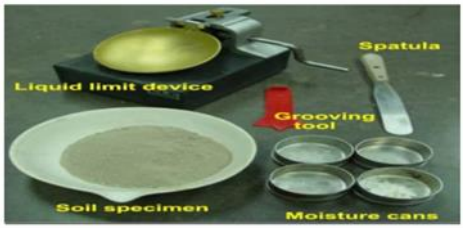


Fig 3: IS SIEVES

B. Liquid limit

Liquid limit has been conducting using standard liquid limit device and Casagrande grooving tool as per the IS. code of practice (1.S.2720 part v; 1985).

The liquid limit test is a type of soil test used to determine the moisture content at which a soil changes from a plastic state to a liquid state, under standardized conditions. It is an important test used in soil mechanics to classify soil types and predict their behavior under various conditions.

Fig 4 : LIQUID LIMIT APPARATUS

C.Plastic limit

The plastic limit has also been determined according to the IS code of practice(IS 2720 part v, 1985). Plastic limit refers to the water content at which a soil changes from a plastic state to a semisolid state. It is also called the plastic limit or the liquid limit of a soil. The plastic limit is an important property of soil that is used to characterize its behavior and to determine its engineering properties.

FIG 5 PLASTIC LIMIT APPARATUS

D. Free swell index

Free swell is the increase in volume of a soil, without any external on strains, on submergence in water. The possibility of damage to structures due to swelling of expensive clay need be identified, at the outset, by an investigation of those soils likely to possess undesirable expansion characteristics. Inferential testing is resorted to reflect the potential of the system to swell under different simulated conditions. Actual magnitude of swelling pressures developed depends upon the dry density, initial water content, surcharge loading and several other environmental factors.

E. Standard proctor test

Optimum moisture content and maximum dry density of soft marine clay and blends of different percentages of fiber were determined according to 1.S light compaction test (I.S:2720(part-7)-1980).

FIG 6 STANDARD PROCTOR TEST APPARATUS

The Standard Proctor Test, also known as the Standard Compaction Test, is a laboratory test used to determine the maximum dry density and optimum moisture content of a soil sample. This test is widely used in geotechnical engineering to assess the properties of soils for construction purposes.

F. California bearing ratio test

The California Bearing Ratio (CBR) test is a measure of the bearing capacity of soils or aggregate materials. It was developed by the California Department of Transportation in the 1930s to evaluate the load-bearing capacity of highway sub grade soils.

Table 1

Penetration of plunger (mm)	Standard load (kg)
2.5	1370
5.0	2055

FIG 7 CBR APPARATUS

Table 2. IS Code Procedures for the determination of properties of materials used in the investigation

S.No	Name of the test	Indian standards code
1.	Liquid limit	IS: 2720(part III)-1980
2.	Plastic limit	IS: 2720(part V)-1965
3.	Light weight compaction	IS:2720(partVII)- 1977
4.	Particle size distribution	IS: 2720(part IV)- 1965

4.0 RESULT AND DISCUSSION FOR CONVENTIONAL SAMPLE

4.1 TEST CONDUCTED ON SOIL:

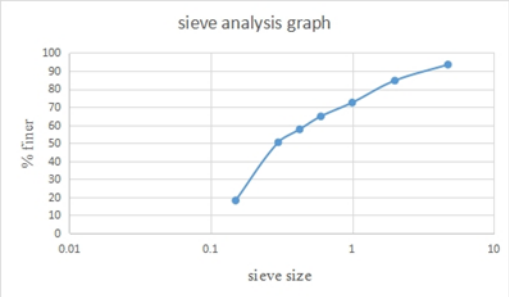
The test conducted on soil are given below

1. particle size distribution
2. Liquid limit
3. Plastic limit
4. Free swell index
5. Standard proctor test
6. California bearing ratio test

4.2 PARTICLE SIZE DISTRIBUTION

Sieve size	Weight retained(gm)	Percentage of retained	Cummulative percentage of retained	Percentage of finer
4.75mm	56	6.5	6.5	93.5
2.00mm	77	8.9	15.14	84.6
1.00mm	105	12.19	27.59	72.41
600 microns	66	7.66	35.25	64.75
425 microns	62	7.2	42.45	57.55
300 microns	62	7.2	49.65	50.35
150 microns	278	32.28	81.93	18.07
75 microns	114	13.24	95.17	4.83
pan	41	4.76	100	0

Table 3: showing particle size distribution values



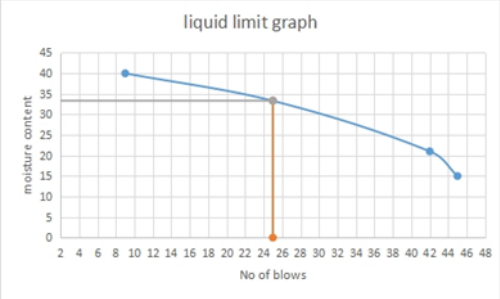
- Accoding to the graph the soil is fine grained soil and contains more amount of clay and medium amount of silt.
- From the graph we analyze that soil is fine grained soil of (size <75 microns).

4.3 LIQUID LIMIT TEST:

S.NO	Amount of water	No of	IPPERSIMoisture

	added (ml)	blows	content
1.	54	45	15%
2.	60	42	21%
3.	72	25	33.3%
4.	78	9	40%

Table 4: liquid limit test results



The liquid limit value obtained for black cotton soil sample is 34%.

4.4 PLASTIC LIMIT TEST:

S NO	Container no	Weight of container (w1)gms	Weight of container + wet soil(w2)gms	Weight of container + dry soil (w3)gms	Moisture content (%)
1.	1	15	24	23	12.5
2.	2	16	24	23	14.29

Table 5: plastic limit test results

Plastic limit value of soil sample is 13.39

Plasticity index :-

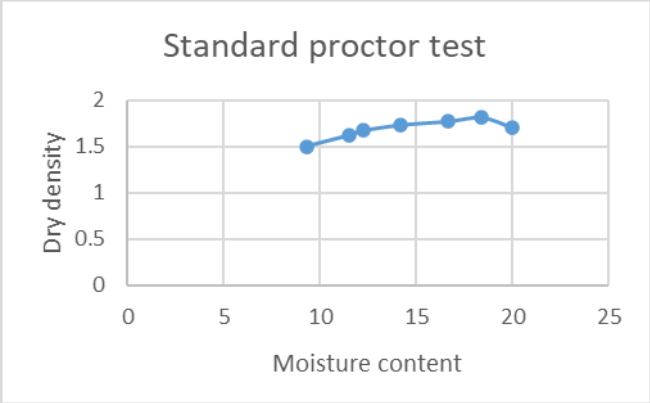
The plasticity index is a measure of the plasticity of a soil. It is defined as the difference between the liquid limit and the plastic limit of a soil.

Plasticity index = liquid limit - plastic limit

=20.61%

- From the plasticity index chart we conclude the soil is In organic clay of high plasticity.
- According to the general property of this soil has poor workability and high compressibility

4.5 FREE SWELL INDEX:



Free swell index of soil sample is 50%

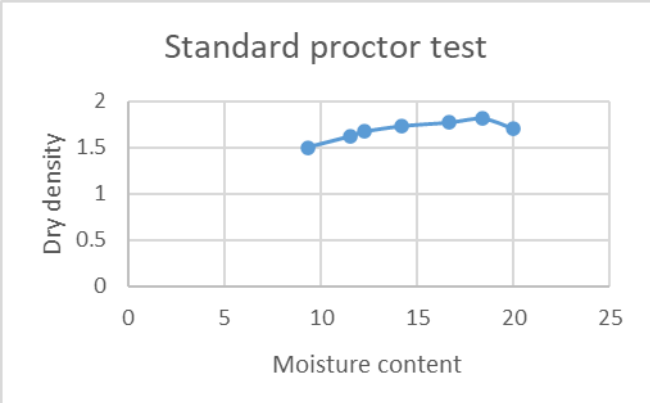
Table 6: Free swell index test result

4.6 STANDARD PROCTOR TEST:

This test was performed on the natural soil samples to specify suitable moisture content for field compaction. The laboratory results are shown with the graphs showing the relationship between dry density and moisture content for the soil samples.

% of shredded rubber tyre	OMC(%)	MDD(g/cm3)
soil	18	1.83

Table7: OMC and MDD Of soil

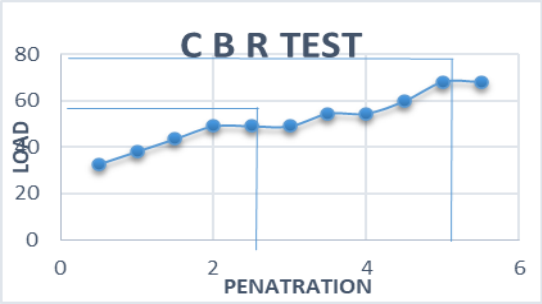


4.7.CALIFORNIA BEARING RATIO:

This test was performed on the samples to readily know the true behavior of the soil and the soil resistance to shear. The results are shown with graphs showing the relationship between the dry densities and moisture content.

Soil type	2.5 mm penetration	5 mm penetration
soil	3.5%	2.91%

Table 8:CBR value of soil



5.0 RESULTS AND DISCUSSION FOR MODIFIED SAMPLE

5.1 COMPACTION CHARACTRISTICS:

Standard proctor test is conducted on soil and shredded rubber tyre mixture to determine ecompaction characteristics, namely the optimum moisture content and maximum dry density. The soil is mixed with the shredded ruber tyre of 4%,6%,8%,10% by weight of soil.The OMC and MDD values are shown below in table.

TABLE 9: OMC and MDD of 4% shredded rubber tyre

%of shredded rubber tyre	OMC	MDD
4%	17	1.82

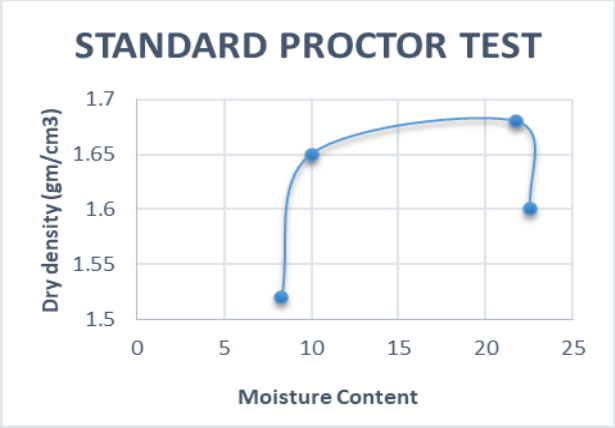


TABLE10: OMC and MDD of 6% shredded rubber tyre

%of shredded rubber tyre	OMC	MDD
6%	13	1.74

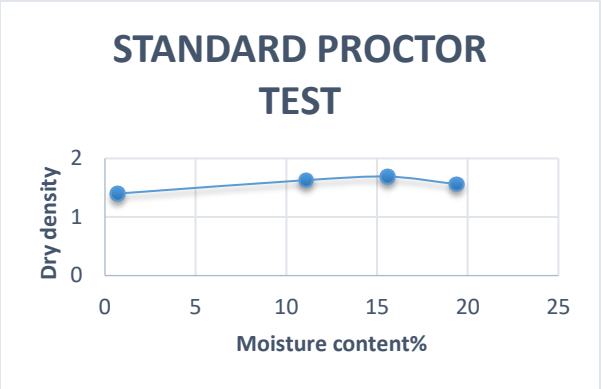


TABLE11: OMC and MDD of 8% shredded rubber tyre

%of shredded rubber tyre	OMC	MDD
8%	11	1.72

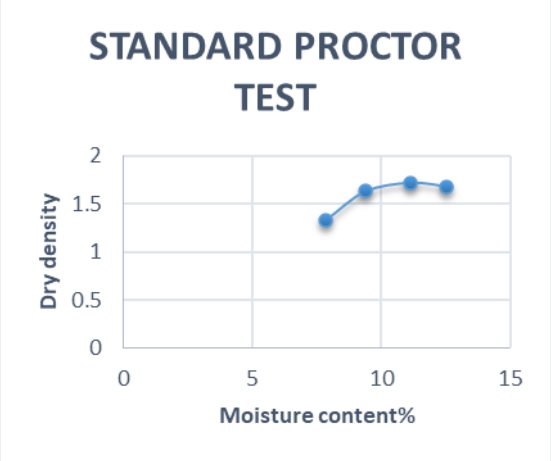
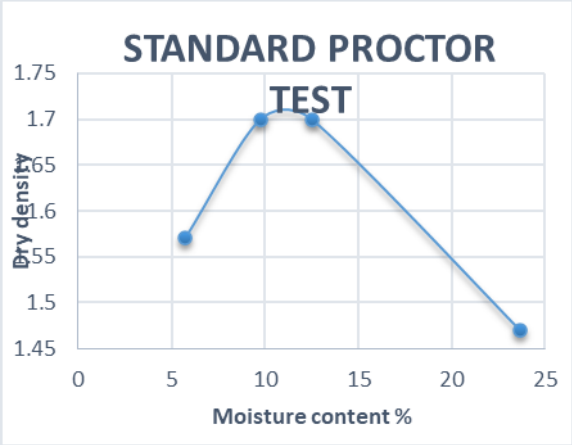


TABLE12: OMC and MDD of 10% shredded rubber tyre

%of shredded rubber tyre	OMC	MDD
10%	12	1.73



CBR VALUES OF SHREDDED RUBBER TYRE:

Table 13: CBR value of 4 % shredded rubber tyre

% of shredded rubber tyre	At 2.5 mm penetration	At 5mm penetration
4%	5.17	2.91

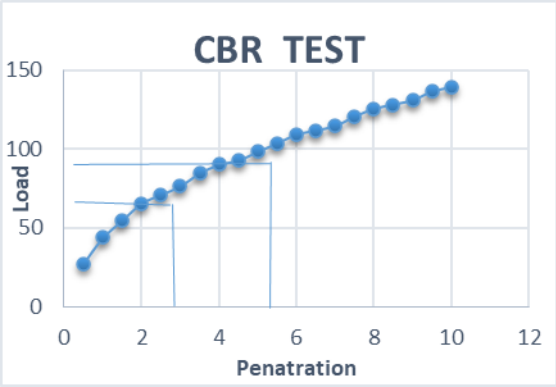


Table14: CBR value of 6% shredded rubber tyre

% of shredded rubber tyre	At 2.5 mm penetration	At 5mm penetration
6%	7.96	8.49

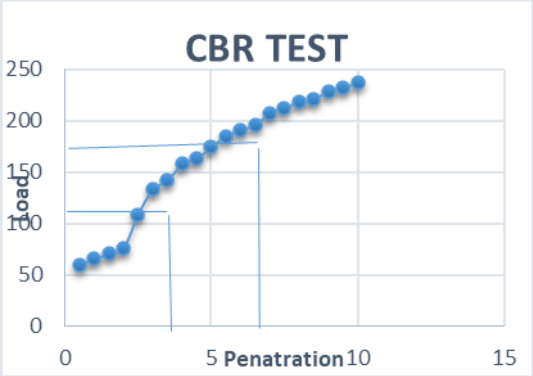


Table 15:CBR value of 8% shredded rubber tyre

% of shredded rubber tyre	At 2.5 mm penetration	At 5mm penetration
8%	9.55	8.89

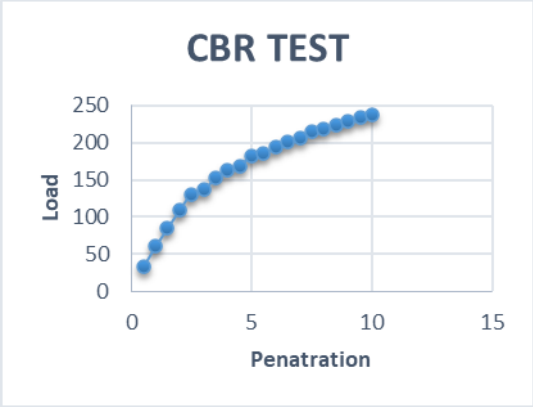
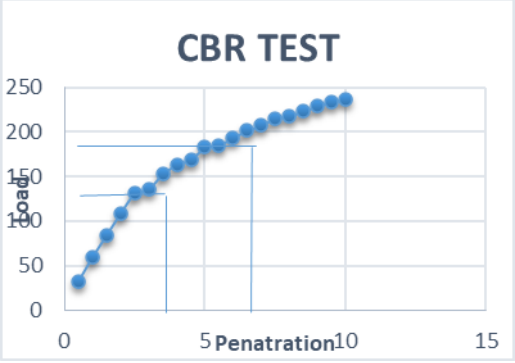


Table 16:CBR value of 10% shredded rubber tyre

% of shredded rubber tyre	At 2.5 mm penetration	At 5mm penetration
10%	8.95	7.83



COMPARISON OF CBR TEST

Table 17: comparison of CBR Test

SNO	Mix propotions	CBR VALUES (2.5mm penetration) (%)	CBR VALUES (5mm penetration) (%)
1.	**Bc soil**	3.57	2.91
2.	**BCSoil+4% shredded rubber**	5.17	4.77
3.	**BCSoil+6% shredded rubber**	7.96	8.49
4.	**BCSoil+8% shredded rubber**	9.55	8.89
5.	**BCSoil+10 % shredded rubber**	8.95	7.83

6.0 CONCLUSION

Based on the experiments carried out on soil and shredded rubber tyre mixture, the following observations and conclusions are drawn :

- Shredded rubber tyre mixed with the soil showed the improvement in CBR value up to 8% and there onwards decreased with further increase in shredded rubber tire.
- The optimum moisture content and maximum dry density is found to decrease with increase in the percentage of shredded rubber tyre .This might be due to light weight nature of the tyre waste.
- The use of shredded rubber as a stabilizer introduces low-cost method for stabilization.
- In addition to this shredded rubber tyre can improve the mechanical properties of soil including increased shear strength for construction purpose.

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