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EFFECT OF SHREDDED RUBBER ON THE PROPERTIES OF EXPANSIVE SOIL

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Abstract - *Properties of soil plays a vital role in the construction of any structures. In order to improve the soil properties, we have to use some admixtures. Usage of vehicle tyres in the world is increasing year by year. Disposal of waste tyres is one of the major problem in the environmental aspect. In this project we are using shredded rubber as an admixture to improve the soil characteristics. Shredded Rubber was added to the soil in size of 3-10mm length & width and 2-3mm thickness with the varying percentage of 2% to 10% by weight at an interval of 2%. Standard proctor compaction test, Unconfined compressive strength test and California bearing ratio test were conducted for soil with the varying percentage of shredded rubber. With the addition of shredded rubber it was observed that there was decrease in optimum moisture content and increase in maximum dry density by adding shredded rubber up to 6%. It was also observed there is an increase in the Unconfined compressive strength & California bearing ratio value at the addition of 6% of shredded rubber. In addition to the above study, lime was added as 1% to 2% with 6% of shredded rubber.*

Key Words: Standard proctor compaction, Unconfined compressive strength, California bearing ratio, Shredded Rubber.

1. INTRODUCTION

Every year over one billion tyres are manufactured worldwide and equal number of tyres are permanently removed from vehicles becoming waste. India's waste tyres account for about 6-7% of the global total. Disposal of waste tyres is one of the major problem faced by the industries. The safe and profitable disposal of these wastes is one of the greatest challeges for the industries. In order to eliminate these problems we have to go for an alternative way. The reuse of waste rubber in the form of powder, chips, shredded is an another way of recycling and disposal. So we are using shredded rubber as an admixture to improve soil characteristics. The following are the some of the literatures we have studied. Jatar Singh & Er.Jasvir Singh Rattan studied about the Soil Stabiization of clayey soil using shredded Rubber Tyre and they concluded that Optimum Moisture Content increase, because shredded tyres have some water absorption value and Maximum dry density decrease is due to the light weight nature of tyre waste, and UCS values increase. Ghatge Sandeep Hambirao & Dr.P.G.Rakaraddi studied about the Soil Stabilization Using Waste Shredded Rubber Tyre Chips and they concluded Unconfined Compressive Strength and California bearing ratio increases with increases in cement and content at an optimum fiber content of 5%. Deepanshu Solanki, Myank Dave & Dr.D.G.M Purohit studied about the Stabilization of Clay Soil Mixed with Rubber Tyre Chips for Design in Road Construction and they concluded the shear strength increased with the increasing amount of rubber up to 0.075 percentage by weight. The value of angle of internal friction increases with increase in percentage of the rubber tyre strips .From the above literature review we are using shredded Rubber of 2-3mm thickness & 3-10mm length and with the varying percentage of 2%-10% by weight at an interval of 2%. The objective of this paper is to study the effect of soil-shredded rubber interaction on the engineering behavior of soil. Soil sample collected from near by site. Standard Proctor compaction Test, Unconfined Compressive Strength Test and California Bearing Ratio Test were conducted for soil with the varying percentage of shredded rubber.

2. MATERIALS USED

The soil used in the study collected from Tiruchendur village, tuticorin district. The shredded used in soil is shown in fig 1. Soil-shredded Rubber mix shown in fig 2. The properties of soil is given below in the table 1.

Fig -1: Shredded Rubber

Fig -2: Soil Shredded Rubber Mixture

Table -1: Properties of Soil

S.No.	Description	Result
1	Colour	Black
2	Atterberg limits	
	i)Liquid limit	57%
	ii)Plastic limit	26.68%
	iii)Shrinkage limit	11.49%
3	Free swell index	38.6%
4	Specific gravity	2.32
5	pH	5.73
7	Grain size distribution	
	i)Gravel	0%
	ii)Sand	22.3%
	iii)Clay and silt	77.7%
8	IS Soil classification system	Clay of High compressibility(**CH**)

3. METHODOLOGY

Collection of data from the various literatures. The soil sample collected from the village. The index properties and engineering properties of the soil determined as per Indian Standards. Shredded rubber of size 3-10 mm length & width and 2-3 mm thickness with the varying percentage of 2-10% by weight at an interval of 2%. Standard proctor compaction test, unconfined compressive strength test and California bearing ratio test were conducted for soil with varying percentage of shredded rubber.

4. RESULTS & DISCUSSIONS

4.1 Compaction Characteristics

Standard Proctor test conducted on soil and soil-shredded rubber mixtures to determine its compaction characteristics, namely Optimum Moisture Content (OMC) and Maximum Dry Density (MDD). The soil mixed with shredded rubber of 2 -10% at an interval of 2% by weight of soil. The OMC and MDD values obtained are shown below in Table 2, Chart 1 shows Variation of maximum dry density for varying percentage of shredded rubber shows the Chart 2 shows variation of MDD for Soil and %of rubber added ,Fig Chart 3 shows Variation of OMC for Soil and % of rubber added.

Table -2: OMC and MDD table for Soil and varying % of rubber added

Amount of shredded rubber added with soil (%)	OMC (%)	MDD (g/cc)
0	21	1.55
2	21	1.56
4	18	1.63
6	15	1.71
8	18	1.64
10	21	1.53

From Table 2, it is observed that the value of maximum dry density increases up to 6% shredded rubber with the soil. After that the maximum dry density value is decreased.

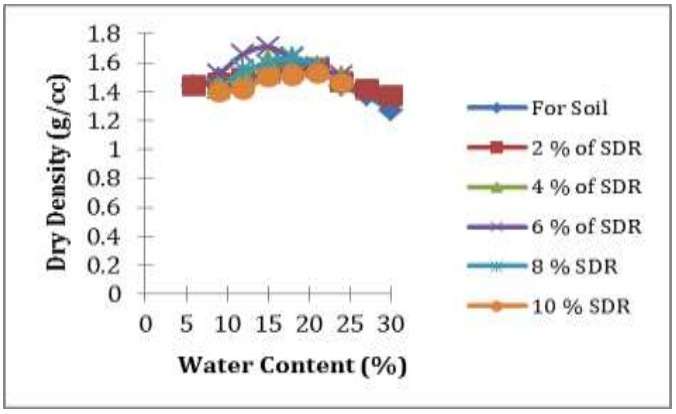

Fig-3: Variation MDD with various Percentage of Shredded Rubber

Figure 3 shows the variation of MDD with various percentage of Shredded rubber. The 6% of shredded rubber gives the maximum dry density and minimum water content. After adding more than 6 % of Shredded rubber the maximum dry density decrease and OMC increase.

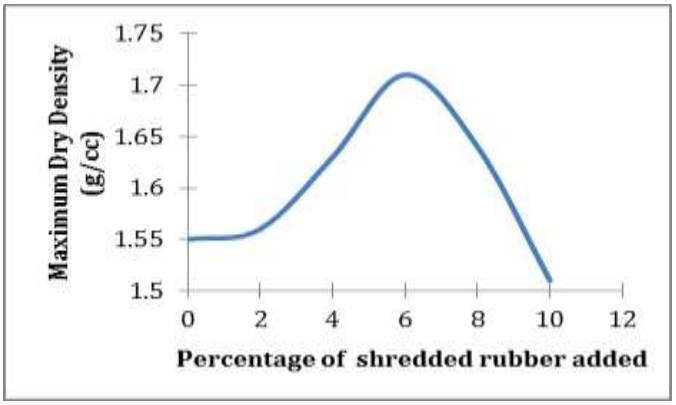

Fig 4: Variation MDD for soil and soil with shredded rubber

Figure 4 shows the variation of MDD for soil with various percentage of shredded rubber .The subsequent increase of shredded rubber in the soil which increase maximum dry density. Adding more than 6% of shredded rubber shows decrease in maximum dry density due to voids space of shredded rubber creates more gap in soil.

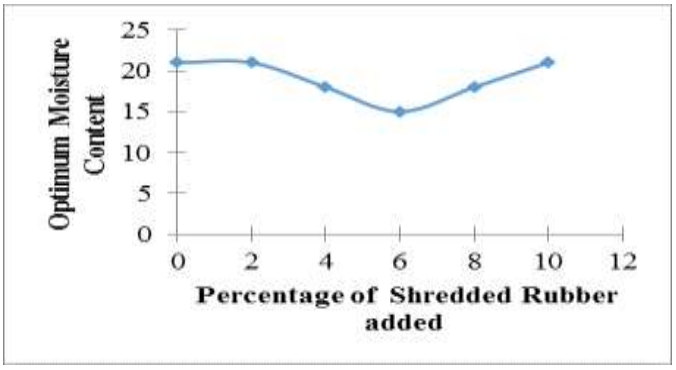

Figure 5: Variation of OMC for soil and soil with shredded rubber

Figure 5 shows the variation of OMC for soil with shredded rubber .The subsequent increase of rubber in the soil which rudce OMC up to 6% addition of shredded rubber. Adding more than 6% of shredded rubber there is increase in OMC due to voids space.

4.2 Strength Characteristics

UCS tests were conducted on soil and soil-shredded rubber mixtures to determine the UCS value. The soil mixed with shredded rubber of 2% - 10% at an interval of 2% by weight of soil. In addition to the above lime was added as 1%to2% with 6% of shredded rubber . UCS of soil and with shredded rubber are shown below in Table 3, Improvement factor for various percentage of shredded rubber are shown below in Table4, UCS of soil with 6% shredded rubber and 1% to 2% of lime are shown below in Table 5, figure 6 shows Variation of UCS for soil and soil with shredded rubber, figure 6 shows stress strain curve for various percentage of shredded rubber, figure 7 shows Variation of improvement factor with shredded rubber, Chart 7 shows Stress strain curve for 6% of shredded rubber with 1% to 2% of lime.

Table -3: UCS of soil with shredded rubber

S.NO	Amount of shredded rubber with soil (%)	Unconfined compressive strength (kN/m²)
1	0	118
2	2	122
3	4	137
4	6	258
5	8	70
6	10	50

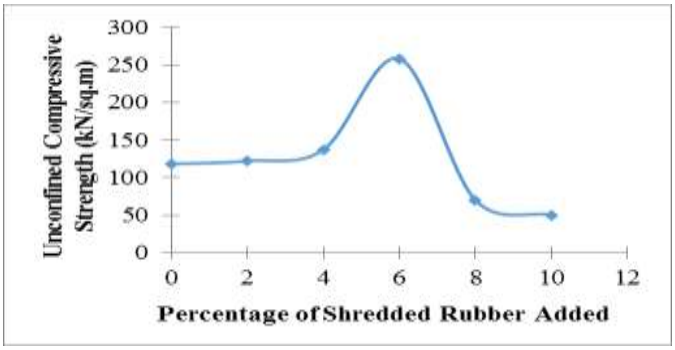

Fig 6: Variation of UCS for soil and soil with shredded rubber

Figure 6 shows the variation of UCS value for soil with shredded rubber**.** The increase in unconfined compressive strength is observed up to 6% of shredded rubber added to the soil. After that, increase the percentage of shredded rubber the unconfined compressive strength is decreased due to the improper bond between the soil and shredded rubber.

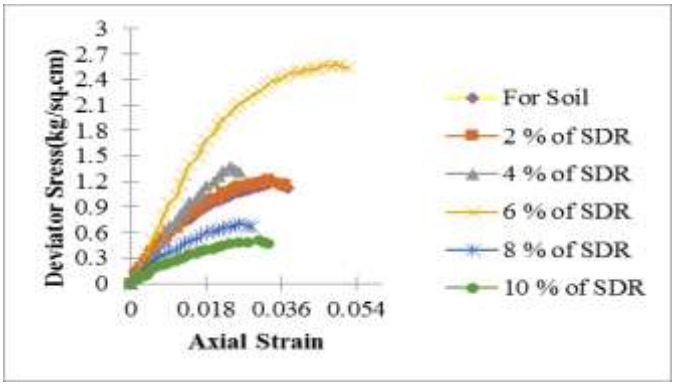

Fig 7: Stress Strain curve for various percentage of shredded rubber

Figure 7 Shows stress strain curve for various percentage of shredded rubber. The 6% of shredded rubber gives the maximum unconfined compressive strength. After adding more than 6 % of rubber unconfined compressive strength value decreases.

Table -4: Improvement factor for various percentage of shredded rubber

Amount of shredded rubber with soil (%)	UCS value (kN/m²)	Ratio of UCS
0	118	-
2	122	1.03
4	137	1.16
6	258	2.18
8	70	0.59
10	50	0.42

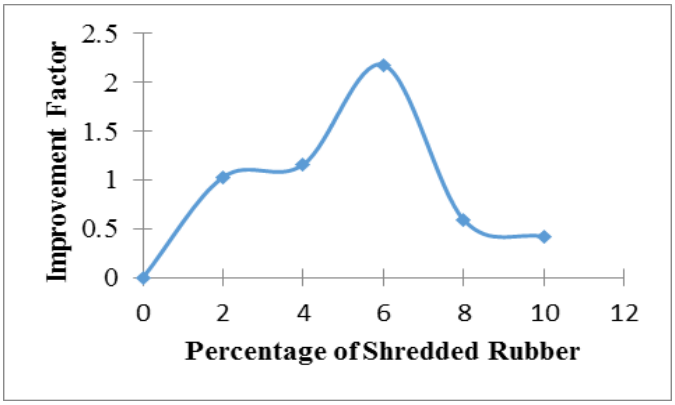

Fig 8: Variation of improvement factor with Shredded rubber

Figure 8 It is observed that, the maximum improvement factor is 2.18 for the 6% addition of shredded rubber to the soil. Up to 6% addition, the improvement factor is increased linearly. Further addition of shredded rubber, the improvement factor is decreased drastically for 8% & 10% of shredded rubber.

Table -5 UCS of soil with 6% of shredded rubber and 1% to 2% of lime

S.NO	Amount of shredded rubber with soil (%)	Addition of Lime added with soil (%)	Unconfined compressive strength (kN/m²)
1	0	0	118
2	6	0	258
3	6	1	300
4	6	2	365

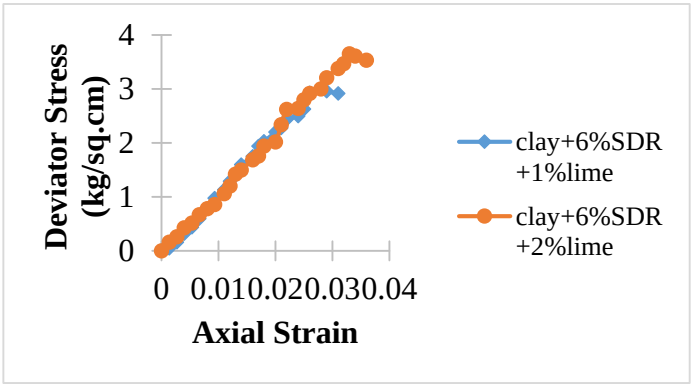

Fig 9: Stress strain curve for 6% of shredded rubber with 1 % to 2% of lime

Figure 9 shows stress strain curve for soil with 6% of shredded rubber and 1% to 2% of lime. 6% of shredded rubber with 2% of lime gives the maximum unconfined compressive strength. Further increase in percentage of lime content, it is observed that the sample absorbed the water and difficult to prepare the sample. Since the sample was broken during preparation itself.

4.3 CBR Value of shredded rubber

CBR tests were conducted on soil and soil-shredded rubber mixtures to determine CBR. The soil is mixed with shredded rubber of 2 -10% at interval of 2% by weight of soil. In addition with keeping constant 6% shredded rubber with addition of 2% of lime. CBR test result with shredded rubber at Table 6, CBR test result with 6% of shredded rubber and 2% of lime at Table 7, figure 10 shows CBR value for 2.5 mm penetration, figure11 shows CBR Value for 5mm penetration, figure12 shows Load vs penetration for various percentage of shredded rubber, figure 13 Load vs penetration for soil, soil with shredded rubber & soil with shredded rubber + 2% of lime.

Table -6 CBR test result with shredded rubber

S.NO	Amount of shredded rubber with soil (%)	CBR value at 2.5 mm penetration (%)	CBR value at 5mm penetration (%)
1	0	5.910	5.160
2	2	6.496	5.450
3	4	6.577	6.030
4	6	7.590	8.270
5	8	7.153	6.470
6	10	4.080	3.847

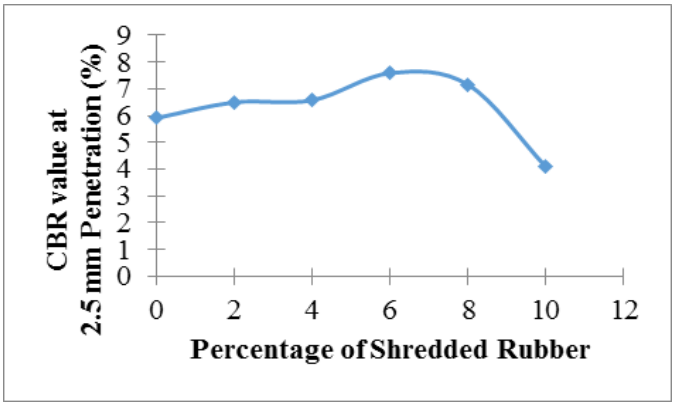

Fig 10: CBR value for 2.5 mm penetration

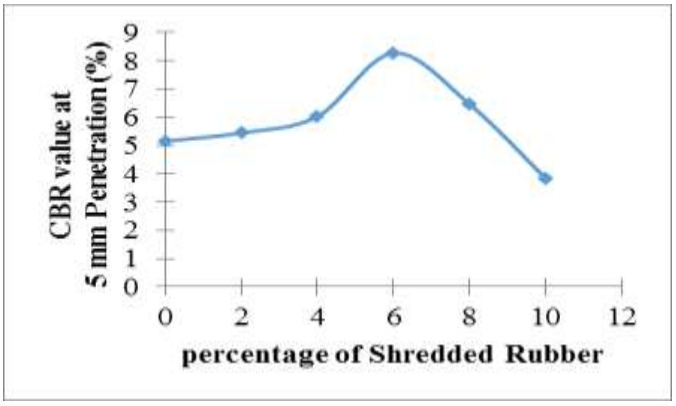

Fig 11: CBR value for 5 mm penetration

Figure 10, 11 & table 6 it is observed that the subsequent increase of shredded rubber increase the CBR value. The 6% of shredded rubber gives maximum CBR value. Further increase the percentage of shredded rubber the value of CBR decreases due to the increase of OMC and shredded rubber content. The CBR value obtained by adding 6% of shredded rubber was found to be 8.27% at 5mm penetration. Which shows an increment of 40% when compared to normal soil.

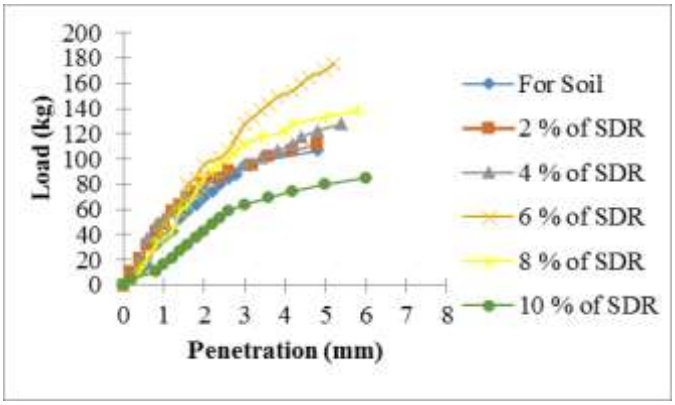

Fig 12: Load vs penetration for various percentage of shredded rubber

Table -7 CBR test result with 6% of shredded rubber and 2% of lime

S.NO	Amount of shredded rubber with soil (%)	Addition of Lime added with soil (%)	CBR value at 2.5 mm penetration (%)	CBR value at 5mm penetration (%)
1	0	0	5.910	5.160
2	6	0	7.590	8.270
3	6	2	10.140	10.320

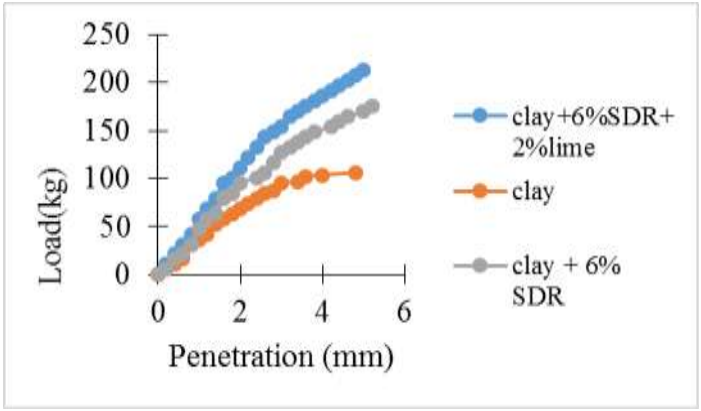

Fig 13: Load vs penetration for soil, soil with shredded rubber & soil with shredded + 2% of lime

Figure 12, 13 & table 7 it is observed that CBR value obtained by adding 6% of shredded rubber & 2% of lime found to be 10.32% at 5mm penetration. Which shows an increment of 25% when compared to soil with 6% of shredded rubber and it shows an increment of 75% when compared to normal soil.

5. CONCLUSIONS

From this experimental study, the following findings are made

1. With the addition of shredded rubber it was observed that there was decrease in optimum moisture content and increase in maximum dry density by adding shredded rubber up to 6%. UCS & CBR value of soil is high for 6% of shredded rubber. Therefore the optimum usage of shredded rubber is 6%.
2. When the 2% of lime is added to 6% shredded rubber, the UCS of soil increased to 365 kN/m² and the CBR value increased to 10.32%. Therefore the soil with 6% of Shredded rubber & 2% of lime is used to enhance the properties of soil.
3. The utilization of this waste material reduces its impact on environment.

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