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RESEARCH ARTICLE

STUDY OF THE BEHAVIOUR OF CLAY SOIL MIXED WITH RUBBER TYRE STRIPS.

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Abstract

Soil is the basic earths toppest layer which support the structure and also the sub base and base course in the pavements. The existing soil at a particular location may not be suitable for the construction due to poor bearing capacity and higher compressibility or due to excessive swelling in case of expansive soils. The improvement of soil at a site is indispensable due to rising cost of the land. In that case the properties of soil can be improved by soil stabilization. soil stabilization a general term for any physical, chemical, biological, or combined method of changing a natural soil to meet an engineering purpose. Improvements include increasing the weight bearing capabilities and performance of in-situ subsoils, sands and other waste materials in order to strengthen road surfaces

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Introduction:-

Soil is the basic earths toppest layer which support the structure and also the sub base and base course in the pavements. The existing soil at a particular location may not be suitable for the construction due to poor bearing capacity and higher compressibility or due to excessive swelling in case of expansive soils. The improvement of soil at a site is indispensable due to rising cost of the land. In that case the properties of soil can be improved by soil stabilization. soil stabilization a general term for any physical, chemical, biological, or combined method of changing a natural soil to meet an engineering purpose. Improvements include increasing the weight bearing capabilities and performance of in-situ subsoils, sands, and other waste materials in order to strengthen road surfaces.

Stabilization in a broad sense incorporates the various methods employed for modifying the properties of a soil to improve its engineering performance. Stabilization is being used for a variety of engineering works, the most common application being in the construction of road and airfield pavements, where the main objective is to increase the strength or stability of soil and to reduce the construction cost by making best use of locally available materials. The scrap tyres are being generated and accumulated in large volumes causing an increasing threat to the environment. In order to eliminate the negative effect of these depositions and in terms of sustainable development, there is great interest in the recycling of these non-hazardous solid wastes. The potential of using rubber from worn tyres in many civil engineering works has been studied for more than 30 years. Applications where tyres can be used have proven to be effective in protecting the environment and conserving natural resources. In recent times with the increase in the demand for infrastructure and feasible foundation design in not applicable due to poor bearing capacity of ground soil stabilization has started to take a new shape. Stabilization is process of fundamentally changing the chemical properties of soft soils by adding binders or stabilizers, either in wet or dry conditions to increase the strength and stiffness of the originally weak soils and with the availability of better research, materials

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and equipment soil stabilization is emerging as a popular and cost-effective method for soil improvement. With the availability of better research, materials and equipment soil stabilization is emerging as a popular and cost-effective method for soil improvement.

Material and test programme:-

This work is done for beneficial utilization of rubber tyre chips and a mix proportion that can be mixed with clay as a best stabilizer with limited detrimental effects. The objective of the present study is to evaluate the use of clay as a construction material after stabilizing it with rubber tyre chips as admixture. The laboratory investigation on clay stabilization with rubber tyre chips as admixture was performed so that it becomes as a base material for road construction and proper foundation material for other types of super structures.

Clay Sample:-

This sample is collected from the Tal Chhapar Sanctuary. The sanctuary is named after Chhapar village which is located at 27°-50' North and 74°-25' East. It is a flat saline depression locally known as a "tal" that has a unique ecosystem in the heart of the Thar Desert. Perched at a height of 302 meters (990 feet) above sea level. Tal Chhaper Sanctuary, with almost flat tract and interspersed shallow low-lying areas, has open grassland with scattered Acacia and Prosopis trees.

Rubber Tyre Strips:-

Shredded rubber tyre was cut into different sizes ranges from 1mm to 25mm (Width) and 3mm to 50mm (Length). Added amount of rubber tyre had been varied in proportions of 4%, 5%, 8% and 10%. The tyre is made up mainly by rubber. Its constitution varies a little between the car tyres and heavy truck tyres. Rubber consists of a complex mixture of elastomers, polyisoprene, polybutadiene and stirene-butadiene. Stearic acid (1.2%), zinc oxide (1.9%), extender oil (1.9%) and carbon black (31.0%) are also important components of tyres.

Preparation Of Soil-Rubber Tyre Chips Mix:-

Plastic reinforced soils were prepared manually by hand mixing. Another thing to note is that for a specified particular percentage of plastic strip content, the plastic strips were mixed in the dry clay manually so that it get distributed throughout the sample.Then the water is added slowly. Sun dried soil after passing through 4.75 mm sieve was taken. Each test was conducted for all three dry densities of clay and bentonite.

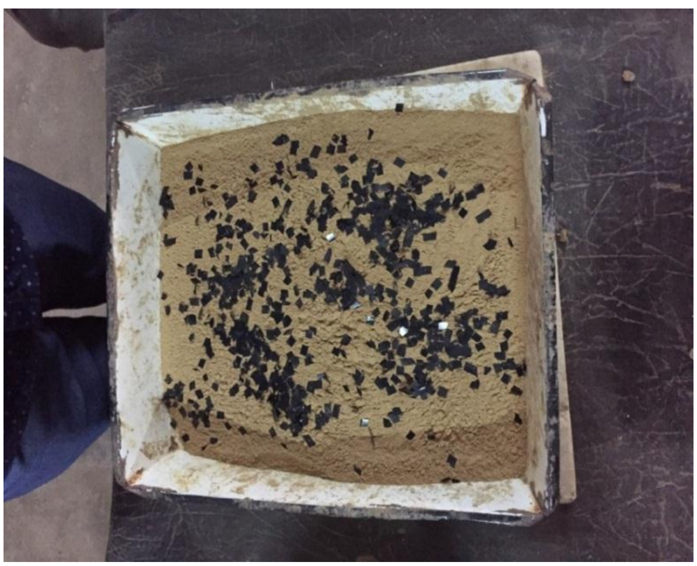


Figure 1:- Mixing of small rubber tyre chips mix in clay

Test Programme:-

The test programme included the preliminary tests for clay and mix compositions of clay with rubber tyre chips. Following tests were carried out:

1 - Standard proctor test
2 - CBR Test

Test Results:-

Standard Proctor Test Results:-

The dry density and water content relationship was obtained from Standard Proctor Test. The OMC and Maximum Dry Density of the plain soil without plastic are obtained from the figure 2 as O.M.C is18 and M.D.D is 1.67gm/cc and also the other dry densities at water content 12 and 24 are 1.61gm/cc and 1.52gm/cc respectively.

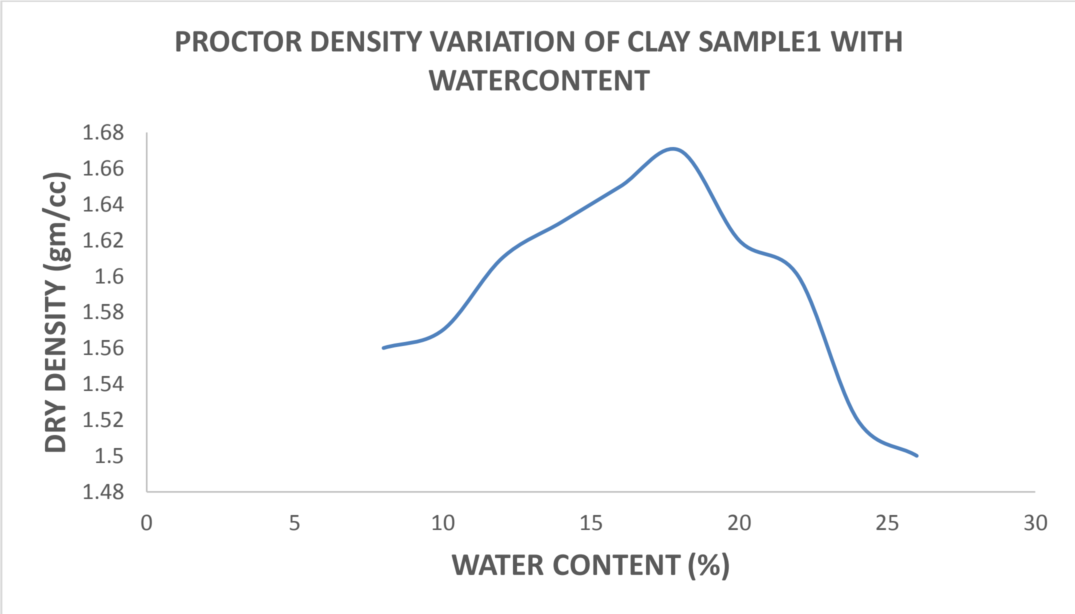
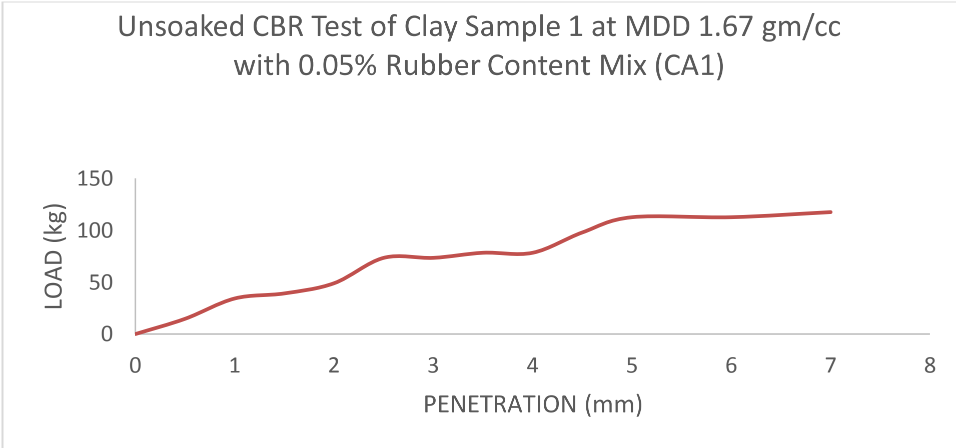


Figure 2:- Proctor Density Variation of Clay Sample with Water Content

Cbr Test Results:-

Various unsoaked CBR test was conducted on sample. Rubber and plastic are mixed with clay in different percentages. There were six types of percentages were used. 0.05%, 0.075%, 0.25%, 0.50%, 0.75% and 1.0%. Rubber and plastic were mixed on the above mentioned percentages with clay and at different MDD the tests were conducted. MDD of 1.52 gm/cc, 1.61 gm/cc and 1.67 gm/cc were used for the experiments. Test results of Unsoaked CBR Test of Clay Sample at MDD 1.67 gm/cc with 0.05% Rubber Content Mix is as shown as tabular and graphical way. Similarly various other tests were done.

S. NO.	PENETRATION (mm)	DIAL READING	LOAD (kg)	% CBR VALUE
1	0	0	0	
2	0.5	3	14.7	
3	1	7	34.3	
4	1.5	8	39.2	
5	2	10	49	
6	2.5	15	73.5	5.364
7	3	15	73.5	
8	3.5	16	78.4	
9	4	16	78.4	
10	4.5	20	98	
11	5	23	112.7	5.484
12	6	23	112.7	
13	7	24	117.6	



The CBR values according to test results for unsoaked condition at MDD 1.67 gm/cc with rubber content 0.05%, 0.075%, 0.25%, 0.50%, 0.75% and 1.0% of the clay are 5.484, 5.722, 6.194, 5.007, 4.530 and 4.291 respectively. For mix composition at 1.61 gm/cc dry density with rubber content mix 0.05%, 0.075%, 0.25%, 0.50%, 0.75% and 1.0% of clay weight the CBR values in percentage are 4.530, 5.245, 5.722, 4.768, 4.291 and 4.291 respectively. For mix composition at 1.52 gm/cc dry density with rubber content 0.05%, 0.075%, 0.25%, 0.50%, 0.75% and 1.0% of the clay, CBR values in percentage are 5.245, 5.961, 6.437, 5.484, 5.245 and 5.245 respectively. According to test results it can be seen that on increment of dry density, the CBR value of the mix composition increases. On increasing the percentage of rubber content firstly the CBR value of the mix composition also increases and then starts to decrease for more percentage of rubber content. The maximum results have been obtained at low percentage of rubber content (0.25%) and minimum results at 1.0% rubber content for all the three dry densities. Hence it can be concluded that to use the mix compositions in base and sub base construction, the CBR values can be increased or decreased as needed. Comparative results for all the three dry densities 1.67 gm/cc, 1.61 gm/cc and 1.52 gm/cc have been shown in graph in figure 3 for unsoaked conditions.

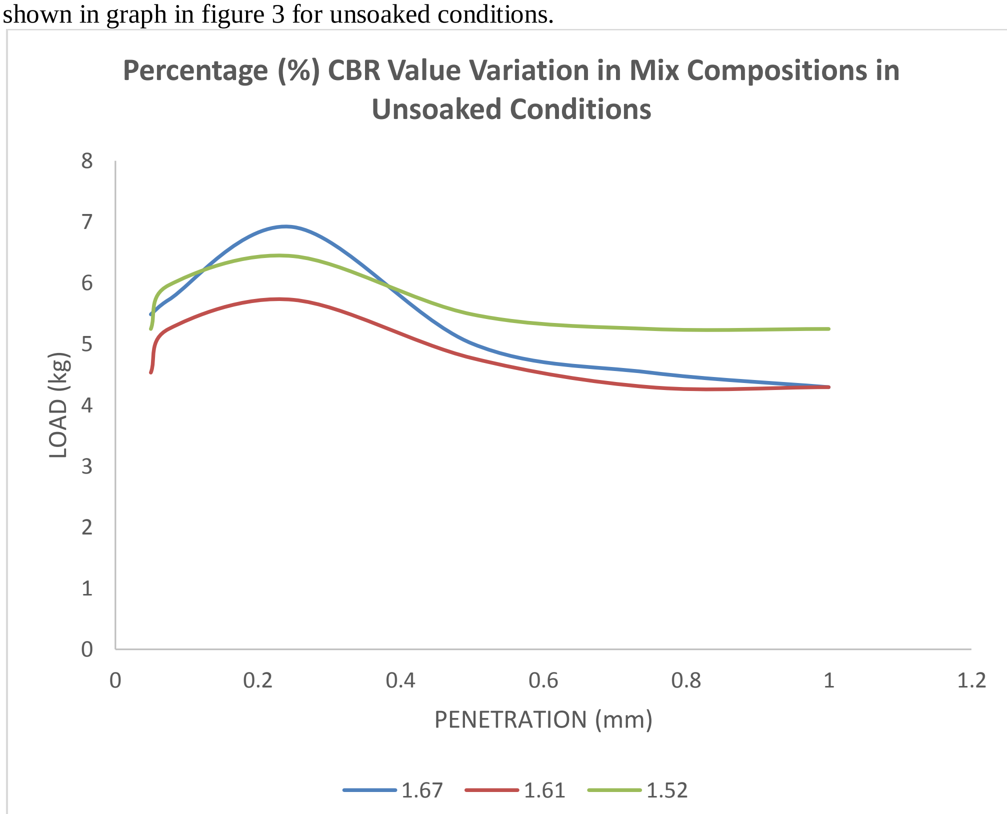


Figure 4:- Percentage (%) CBR Value Variation in Mix Compositions in Un soaked Conditions

Conclusion:-

After analysis of the test results presented in the tables and figures of plotted graphs, the following conclusion are drawn regarding the performed experimental study:

1. The rubbershreded waste usage in the investigation has the potential to reduce the environmental menace of rubber waste.
2. As the results indicates that the soil characteristics such as gradation, particle size, shape and plastic parameters such concentration in the specimen, strip size are affects the strength behavior of the rubber -reinforced soil.
3. The results indicate that the initial void ratio was higher for plain soil and as the rubber waste was added it being lower. As the percentage of rubberwaste increased in soil, the density of rubberwaste being less, more voids were occupied with rubberwaste and resulted in overall reduction of void ratio.
4. The study indicates that the Angle of internal friction (ϕ) increases with increase of percentage of rubberstrips content in the mix composition. Less percentages of rubbercontents are giving optimum values. Those values for clay sample 1, clay sample2 at MDD are 15.700", 17.730 respectively.
5. The values of friction angle increases as the dry density of clay increases. The increase in strength in soil is due to increase in friction between soil and rubberwaste and development of tensile stress in the rubber.
6. Shear strength increases with increasing amounts of rubberup to 0.50% for clay sample 1, 0.075% for clay sample 2 by weight, beyond which the gain in strength is smaller. The smaller grain size provides greater contact area and better surface frictional resistance between clay and fibers.
7. The results of CBR test indicates that the proper mixing of rubberstrips in soil with appropriate amount improved strength and deformation behavior of subgrade soil. It is appropriate to say that the reason behind the above conclusion is, the interaction between soil and rubberwhich causes the resistance to penetration of the plunger resulting into higher % CBR Values.
8. The notable improvement properties that found are shear strength, ductility, toughness, isotropy in strength, % CBR Value etc. up to a limiting value referred to as the critical confining stress, failure occurs by frictional slipping of the reinforcement.

Suggestions For Further Studies:-

The results of this study suggest that strips cut from polythene may prove useful as soil reinforcement in highway and light-duty geotechnical applications. However, further study is needed to:

1. Optimize the size and shape of the strip.
2. Assess the durability and aging of the strips.
3. Mathematical modeling can be done so that improvement of subgrade of a road structure may be predicted from the properties of soil, and plastic content to be used in subgrade to help the practicing geotechnical engineers.
4. Determine the economic benefits that can be accrued through their use. Larger-scale tests should also be conducted to determine if boundary effects influence the test results.
5. polythene wastes can be used in varying shapes too, just like the soil gravel particles like angular, rounded, etc.
6. Waste hard plastics can be used in bricks or concrete but it has to be molded as required first.

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