International Journal of Multidisciplinary Research and Development
Online ISSN: 2349-4182, Print ISSN: 2349-5979; Impact Factor: RJIF 5.72
Received: 27-05-2019; Accepted: 29-06-2019
www.allsubjectjournal.com
Volume 6; Issue 8; August 2019; Page No. 122-125

Tyre rubber powder as a soil stabilizer

Rajvinder Kaur[1], Er. Dalvir Singh[2]
[1] Student, Department of Civil Engineering, Arni University, Kathgarh, Indora, Himachal Pradesh, India
[2] Associate Professor, Department of Civil Engineering, Arni University, Kathgarh, Indora, Himachal Pradesh, India

Abstract
The amount of tire wastes, an unwanted urban- industry surplus, has been increasing every year throughout the world. One of the chances to dispose of this waste material is to use these refuses, as a stabilizer in soil, in order to increase the strength properties and bearing capacity of the soil stabilizer mixture. In this thesis, in order to study the influence of tire waste on shear strength and bearing capacity of soil, experimental has been performed on soil sample with different tire ratio powder of waste have been used in this study. Various crumb rubber powder having 0%, 5%, 10%, 15% were chosen. To find the effect of tire waste on shear strength direct shear test device has been used and CBR test apparatus has been utilized to study the effect of tire waste on the bearing capacity of the stabilized soil. It was found that shear strength of black cotton soil is increased with addition of 10% of CRP
Addition of 10% of CBR to the soil increases CBR value but if the percentage of CRP increase more than 10%, the soil strength gradually decreases.

Keywords: crumb rubber, soil stabilization, particle size, powder, black cotton soil, strength of soil

Introduction
In today's world due to rapid growth of urbanization and modernization leads to security of land for construction. The increasing value of land and due to limited availability off site for construction of structures and roads are done of land having expensive clays. This stability of structures of road depend on soil properties on which it has built. The constructions can be economical if the soil is good at shallow depth below the ground surface. Developing countries like India mainly depend upon on the transportation sector for their economic growth. There is a continuous development and at large scale uses of motor vehicles. The growth and uses of motor vehicles have not only caused noise pollution, air pollution etc. But also has created problems in discarding the tires. Rubber does not decompose and as a result, an economically feasible and environmentally sound disposal method has to be found out. One of the common and feasible way to utilized these waste products is to go for construction of roads, highways and embankments. If these materials can be suitably utilized in construction of roads, highways and embankments then pollution problems caused by the industrial wastes can be greatly reduced. Huge amount of soil is used in the construction of roads and highways but sufficient amount of soil of required quality is not available easily. Utilization of various industrial wastes such as crumb rubber as a soil replacement not only solves environmental problems but also provided new resource for construction industry.
Structures are not only constructed on the soil but also with soil for example embankments, Earth dams, airfields and Highway payments. Soil in general are used as constructed material as available in nature with the little processing.

Objective of study
Main objective of soil stabilization is to improve the onsite material to create a solid and strong sub base and base course. Thus, the goal of soil stabilization is to provide a solid stable foundation. Soil stabilization is used to reduce the permeability and compressibility of the soil mass in earth structures and to increase its shear strength. Soil stabilization is required to increase the bearing capacity of foundation soils.

Literature review
In a present environmental and economic ambience high pressure are laid on engineers to identify suitable methods whenever possible to reduce any locally available waste materials in order to minimize the cost 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 tire 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 nonrenewable. This soil often is weak and has no enough stability in heavy loading. The aim of the study was to review on stabilization of soil using low cost methods. Based on literature shredded rubber tire can be used as light weight either in the form of a whole tires, shredded and chips for tin mix with soil. The overview has brought out the need for reinforcement. With same intention literature review is undertaken on utilization of solid waste material for stabilization of soil and their performance. Soil stabilization is the process of improving the engineering properties of soil and thus making it more stable. It is required when this soil available for construction is not suitable for the intended purpose. Soil stabilization is used to produce the permeability and compressibility of soil mass in structures and increase shear strength.

Methods of stabilization may be grouped under two main types:

- Modification or improvement of soil property of the existing soil without using any admixture.
- Modification of properties with the help of admixture.

The example of the first type are compaction and drainage, which improve the inherent shear strength of soil. The example of second type stabilization with admixture like cement, lime, bitumen, fly ash and chemicals Rao and Datta, (2001) [2] conducted studies on sand mixed with rubber chips. Compressibility tests and triaxial tests were conducted. The stress strain relations and strength parameters was studied. It was found that the value of internal friction are effective cohesion of sand increase with increase in percentage of rubber up to 15%.

Ghazavi, (2004) investigated the suitability of recycled granular rubber as a light weight backfill material. He observed that the unit weight of the soil was reduced from approximately 14 KN to approximately 8KN original for the 70% rubber blend. Ghazavi concluded that

1. Addition of rubber to sand did not improve the shearing resistance ofblends.
2. An apparent cohesion of approximately 10 KPa was obtained from blends containing rubber gain.
3. Initial frictional angle decrease with increase in percent of rubber.
4. Unit weight of bland decrease with addition of rubber.

Ventappa and Dutta, (2006) performed a study with objective of determining compressibility and strength characteristics of sand and tire mixture for suitability of sand tire chips mixture for embankment. They concluded that up to 20% compressibility of sand tire mixture was 1% i.e. in in tolerance limit for 10m height of embankment and produced cohesion between 7 - 17.5KPa and also internal frictional angle increased from 38 to 40 degree.

Cabalar, (2011) blended GTR with stands from two geologic formation, Leighton Buzzard Sand (LBS) and Ceyhen Sand (CS). These stands were selected for their differences in structures and engineering properties. LBR is coarse with sub angular particles, and CS is fine with angular particles. The rubber particle size was not listed but the particles were described as "flaky". Rubber was planted with each type of stand 5, 10, 120, 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 leveled off. He concluded that the blendwere useful as lightweight embankment fill on weak foundation soils and retaining wall backfill material since sand rubber mixtures were significantly lighter than 100 percent sand mixtures.

H Trouzine, M Bekhiti, A Asroun (2012) [5] An experimental program was undertaken to investigate the effects of scrap tyre rubber on the swelling behaviour of composite clayey soils, using a large mix ratio. Two soils was studied (Ataida and bentonite soil in the north-west of Algeria) by considering the high compressibility and low water absorption of scrap tire rubber. Grain size, specific gravity, atterberg limits analysis, swell consolidation on the two soils and there admixture with varying fibre content (10%, 20%, 25% and 50%). The results show that the liquid limit, swell potentials, swelling pressure and time to reach maximum heave decrease gradually when the scrap rubber content increases, and this reduction is significant for the soil with the highest swelling potential.

Owning to the high compressibility of scrap tire rubber, the compression and recompression indexes increase considerably with the content of scrap tire rubber. It appears from results that scrap tire rubber can be used as reinforcement materials for the modification of clayey soils, yet with a content it that should not greatly affect the mixture compressibility.

PT Ravichandran, A Shiva Prasad, K Divya Krishnan, PR Kannan Rajkumar, (2016) [4] In this work, the possibility of using crumb rubber powder was an additive to improve the strength of soft soil was investigated. Two type of problematic clay soils are stabilized with the various percentage of crumb rubber (0%, 5%, 10% and 15%). The strength properties of stabilized soil were improved by increasing percentage of crumb rubber up to 10% is studied by the CBR tests. In addition to strength development, the influences of this stabilizer type and different quantities on drainage characteristics are also studied. Addition of crumb rubber in both the soils shows desirable change in permeability. With the addition of crumb rubber of 10% shows the improvement in CBR value of soil is 161 % and 130% in soil A1 and A2. The results obtained shows that both strength and permeability modification results in the better stabilization for clayey soil.

Methodology

Process of manufacturing of rubber powder

Three steps of manufacturing the tire into powder:

- Shredding
- Granulation
- Pulverizer

For this purpose crumb rubber powder used as stabilizing material. For improving the engineering properties of clay, crumb rubber was chosen as an additive. Crumb rubber powder (CRP) is a term used usually applied to recycled rubber from automotive and trucks scrap tires. Doing did cycling process steel and fluff is removed leaving the rubber with a granular consistency. Continuous process with a granular and/or cracker mill possibly with the aid of mechanical means, reduce the size of the particles further. The CRP is which is used as an additive in the present study to get desired and sending property in the available problem clay.

Solid waste management has gained a lot of attention in the research field. Out of the various solid waste, accumulated waste tires has become a problem of interest because of its non-biodegradable nature. With the increase in the automobile production, huge amounts of waste tire need to be disposed.

Most of the waste tire rubbers are used as a fuel in many industries such as thermal power plant, cement kilns and brick kilns etc. This kind of usage is not environment friendly and requires high cost. So it's become necessary to think about alternates for waste tire rubber consumption. Waste tire rubber is a promising material in the construction industry due to its light weight, elasticity, energy absorption, sound and heat insulating properties. Thus the use of scrap tire rubber in the soil stabilization has been thought as an alternative disposal of such waste tires to protect the environment. Waste tires have characteristics that make them not easy to dispose, and potentially combustible. This

technique has been gaining popularity in the field of geotechnical engineering due to its highly versatile and flexible nature. A small amount of rainfall, such as 6mm can make black cotton soils impassable for all traffic. Due to plastic nature, the black cotton soils stick onto wheels, animals' feet, clog cultivation machines, and are hard to remove. Expansive nature of this soil negatively affects its bearing capacity. When dry, black cotton soil is so hard that the clods cannot be easily pulverized for treatment for its use in road construction. This leads to serious problems related to consequent performance of the road. If black cotton soil stabilization is not applied, the damage will be apparent usually several years after construction

Replacement of expansive soil with a non- expansive material is a common method of reducing shrink-swell risk. In the case when expansive soil or stratum is thin, then the entire layer can be removed. However, often the soil or stratum extends too deep and in that case this method is not economically efficient. One of methods of black cotton soil stabilization is wetting in order to saturate soil and thus prevent potential expansion if the high moisture content can be maintained.

Materials

For the present study we have use the following materials: Black cotton soil Crumb rubber powder

Preparation of samples

The first step in preparing a soil for testing was to air dry the soil. This was accomplished by spreading the soil over a large area. This soil was spread this enough so that it could completely a dry in few days. When the soil had very high clay content, much more time was invested in spreading the sample out. This typically included breaking the sample into small section, so that it could a dry in a reasonable time. The length of time each sample was left out to air dry depend on its moisture content. Some of the very moist samples took up to 5 days to dry. In order make sure the samples were properly dried, the 20 kg sample was placed in an oven at 60 degree Celsius to 140 degree Celsius for one day.

Test conducted on samples

For the stabilized soil specimens, a step percentage of crumb rubber powder (CRP) by dry weight of soil (0, 5, 10, 15) was introduced into the soil.

Various tests and analysis were carried out to examine the effects of crumb rubber powder (CRP) on the expensive soil namely.

Particle size distribution-by sieve analysis

Atterberg's limits (liquid limit plastic limit) by casagrande apparatus Shear strength by Direct Shear Test Free swell index test Specific gravity-by pycnometer method CBR(California bearing ratio)-CBR test

Table 1: Percentage of soil, rubber powder and lime.

Sample	Soil (%)	Crumb rubber Powder (%)
A	100	0
B	93	5
C	86	10
D	79	15

Table 2: Properties of prepared sample

S. No.	Name of parameter	For Black cotton soil
1	Specific gravity	2.423
2	Free swell index	82.14%
3	Liquid limit	44.9%
4	Plastic limit	33.72%
5	Plasticity index	11.18

Fig 1: Crumb rubber powder Calculation from CBR test below

Table 3: California bearing ratio for black cotton soil

Penetration (mm)	Load (kg/cm square)			
	0% of rubber powder	5 % of rubber powder	10% of rubber powder	15% of rubber powder
2.5	6.109	9.175	10.233	4.963
5	4.649	7.978	9.759	7.715

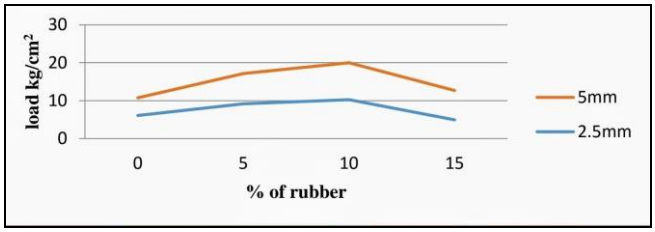

Fig 2: Graph of California bearing ratio for black cotton soil

Table 4: Shear strength for black cotton soil

Penetration (mm)	Shear stress (kg/cm square)			
	0% of rubber powder	5% of rubber powder	10% of rubber powder	15% of rubber powder
0.5	1.94	2.5	2.78	2.91
1	2.5	3.19	3.33	3.33
1.5	2.5	3.61	3.89	3.75
2	2.63	4.16	4.30	4.16
2.5	2.77	4.44	4.72	4.58

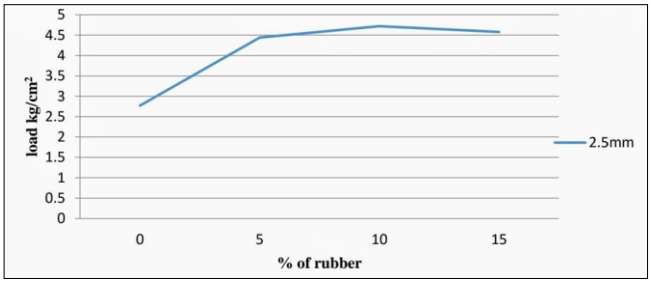

Fig 3: Graph of direct shear for black cotton soil

Conclusion

The shear strength of black cotton soil is increased with addition of 10% crumb rubber powder.

From the investigation, addition of 10% of crumb rubber powder to the soil increases CBR value.

This investigation evaluation 10% is the optimum rubber powder for the stabilization of black cotton soil.

If the percentage of rubber powder increases more than 10%, the soil strength gradually decreases.

Observing its economic cost and quality of stabilization improvement, it is clear this type of stabilization may be applicable in stabilization of black cotton soil in construction of road or in shoulder portion of highway.

References

1. Ravi Kumar G, Gayathri K. Evaluation of crumb rubber powder, 2018.
2. Gatge Sandip Habirao, Rakaraddi PG. Soil stabilization using shredded rubber tyre chips, IOSR journal of mechanical and civil engineering (IOSR-JMCE).
3. Shri Vasavi B, Prasad DSV, Prasad ACSV. Stabilization of soil using crumb for rubber powder and cement. International journal of innovative research and technology. 2001; 2:8.
4. Ravichandran PT. A Shiva Prasad, K Divya Krishnan, PR Kannan Rajkumar Indian journals of science and technology. 2016; 9(5):1-5.
5. Trouzine H, Bekhiti M, Asroun A. Geosynthetics international. 2012; 19(2):124-132.
6. ASTM D1883- 07e2. Standard test method for CBR (California bearing ratio) of laboratory compacted soils", American society for testing of materials, Pennsylvania, USA, 2007.
7. ASTM D2487-10. Standard practice phone classification of soils for engineering purpose (unified soil classification system), American society for testing of materials, Pennsylvania, USA, 2010.
8. IS 2720 part- 5"Methods of test for soil determination of liquid limit and plastic limit.
9. IS 2720 part-8"methods of test for soil determination of water content dry density relation using a heavy compaction.
10. Guruprasad Y, Sai Niharika V, Satheesh D, Tejaswini G, A Nandini Strength improvement of expansive soil by using tyre powder, 2018.