Evaluation of Strength Characteristics of Clayey Soil Using Shredded Rubber Tyre Chips and Rice Husk Ash

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Abstract - *soil being one of the most valuable materials used in different construction projects including multi-storied buildings, earth canals and earthen dams. Most of the failures of soil have been attributed to poor strength. Stabilization of soil by adding lime, cement, bitumen etc. are expensive and therefore require an economic replacement.*

Shredded rubber tyre chips, is a new generation material, which have gained attraction towards the soil reinforcement. It can be obtained from waste rubber tyres almost 70% tyres are directly disposed into the enviroment.It is manufactured in the controlled conditions with special equipments to produce optimized size distribution which is its unique property.

Shredded rubber tyre chips are obtained from wastes rubber, which helps in soil stabilization of clayey soils, the performance of Shredded rubber tyre chips, is superior to all the other materials used in India. Hence, the utilization of Shredded rubber tyre chips for soil improvement will be a welcome development. In this thesis work, I studied the suitability of Shredded rubber tyre chips as a possible material to improve the strength of soils.

There was a sharp increase in UCS with addition of Shredded rubber tyre chips at all ages indicating the abnormal and high strength behavior of Shredded rubber tyre chips the compressive strength increases with addition of Shredded rubber tyre chips in comparison to without Shredded rubber tyre chips at all ages. The compressive strength was found to be maximum at 28 days with 10% Shredded rubber tyre chips. The object of our present studies is to improve the various properties of clayey soil by mixing locally available material, hence Rice Husk Ash, which is locally and easily available material, selected to mix with clayey soil in different proportions. The admixture was collected from rice milling factory at budgam j&k.

Three proportions of SRTC used is 11%,13%,15%,17% by weight of dry soil and variation of Rice Husk Ash is 9%, 10%, 11% respectively. The analysis was done by conducting compaction, atterberg limits, compaction test, UCS and California bearing ratio tests. It was observed that Shredded rubber tyre chips and Rice husk ash had significant effect in the engineering properties of the soil. The results showed that the unconfined compression strength, California bearing ratio values had increased with increase in shredded rubber tyre chips content up to certain limit.

Key Words: shredded rubber tyre chips, rice husk ash, ultra finesss. Clayey soil, atterberg limits, compaction test, UCS, CBR

1. INTRODUCTION

Soil is the uppermost-unconsolidated material of the earth present naturally in the universe. It is formed by the decomposition of rocks under the influence of naturally occurring conditions such as wind, rain, snow, heat, etc. The characteristics of soil change according to topography and its location.These soils show settlements, low shear strength and high compressibility.

Clayey soil is one of the types of soil composed of very small particles, and usually it contains silicates of aluminum and/or iron and magnesium. Clayey soil swells in wet condition and shrinks in dry condition.

The clayey soils being expansive in nature need to be stabilized in order to improve its various geotechnical parameters like strength, settlement control, shrinkage, swelling etc. which can be done by numerous ways and here I would be discussing the strength improvement by shredded rubber tyre chips and rice husk ash.

1.1 materials

1.1.2 Clayey soil

Clayey soil being one of the types of soil is composed of very fine particles, and it contains silicates of aluminum or iron and magnesium. The flow of water is usually hindered by clayey soil, meaning it slowly takes up water and then holds it for a long duration of time. Volume of Clayey soil increases in wet condition and decreases in dry condition.

Clayey soils are often very gluey and roll like plastic when they are in wet condition. They can retain more total water than most of the other soil types.They remain wet in winter and so stock should be taken off the land to avoid poaching (the compaction of soils by animals' hooves).

They usually take time in gaining temperature in the spring because moisture present in them heats up more slowly than mineral matter. They are normally rich in potash, but lack phosphates .Clay soils usually have to be mixed with the lime. Over liming may not cause any problems like deficiency. The clayey soils being expansive in nature need to be stabilized in order to improve its various geotechnical parameters like strength, settlement control, shrinkage , swelling etc which can be done by numerous ways and here I would be discussing the strength improvement by shredded rubber tyre chips and rice husk ash.

1.1.3 shredded rubber tyre chips

In civil engineering field, waste materials such as waste rubber tyres, have attracted attention to be used in soil reinforcement. Approximately 240 million tyres are being traded in each year, almost 70% or 170 million tyres are disposed of directly into the environment. The most common disposal end point is privately and publicly owned stockpiles, which account for around 100 million tyres/,tubes annually. Approximately 28 million tyres are disposed of in landfills, and 38 million tyres are randomly dumped on roadsides or in rural areas. While these estimates alone are quite large, they do not include the huge backlog of scrap tires from previous years. The stock of tyres and tubes from past stockpiling has been estimated to be over 2.4 billion (GIA, 2013). In Western Australia around 48.5 million equivalent passenger unit (EPU) waste tyres/tubes were produced in 2009-2010 (Brindley et al., 2012). Consequently, waste tyres/tubes are occupying a considerable amount of valuable space in landfill sites, resulting in severe environmental consequence and an increasing need for new landfill sites (Fig.3.2). The objective of this study is to control the pollution caused by dumping of waste rubber tube to a large extent. This urges the need for an alternative, enviromental friendly way of tube disposal. The study presented in this work is part of an ongoing research to provide good means of consuming the millions of scrap tube that are taken for stock piling of used tubes. Therefore, reuse of waste tubes and tyres should be seriously considered.

This 75,000-tones tyre/tube dump near Madrid has presented Spanish authorities with a big problem (BBC NEWS, 2016)

There are six major tyre and tube disposal end points which are representative of the total disposal mix: landfills, stockpiles, random dumps, retreads, asphalt mixtures, and energy feeds. The first three end points account for a significant portion of disposed tires. Asphalt mixtures and energy feeds represent the most economical and technically feasible options that could absorb a significant portion of the tyre and tube being disposed. There are also some applications of the waste tyres in civil engineering such as in embankment construction or drainage layers in landfills(Balunaini et al., 2014). However, considering the ongoing increase in the amount of waste tyre and tube, more studies are required to find other applications for theses wastes.

1.1.4 Rice husk ash

Rice milling generates a by-product known as husk. This surrounds the paddy grain. During milling of paddy, about 78% of weight is received as rice, broken rice and bran. Rest 22% of the weight of paddy is received as husk. This husk is used as fuel in the rice mills to generate steam for the boiling process. This husk contains about 75% organic volatile matter and the remaining 25% of the weight of this husk is converted into ash during the firing process, known as Rice Husk Ash (RH). This RH in turn contains around 85% - 90% amorphous silica. So for every 1000 kg of paddy milled, about 220 kg (22%) of husk is produced, and when this husk is burnt in the boilers, about 55 kg (25%) of RHA is generated. The husk generated during milling is mostly used as a fuel in the boilers for processing paddy, producing energy through direct combustion and/ or by gasification. This RHA is a great environmental threat causing damage to the land and the surrounding area in which it is dumped.

1.2 Mix proportions

Table-1: mix proportion of soil(s), rice husk ash (RHA) and shredded rubber tyre chips (SRTC)

S.NO	DESIGNATION (S:RHA:SRTC)
1	100 : 0 : 0
2	80 : 11 : 9
3	78: 13 : 9
4	76 : 15 : 9
5	74 : 17 : 9
6	79 : 11: 10
7	77 : 13 : 10
8	**75 : 15 : 10**
9	73 : 17 : 10
10	78 : 11: 11
11	76: 13 : 11
12	74 : 15 : 11
13	72 : 17 : 11

1.3 Objectives

- To calculate the consistency limits and compaction characteristics of untreated clayey soil.

- To calculate the MDD and OMC Value of Clayey soil with Shredded rubber tyre chips and Rice husk ash.
- To calculate the CBR Value of Clayey soil with Shredded rubber tyre chips and Rice husk ash.
- To calculate the UCS Value of Clayey soil with Shredded rubber tyre chips and Rice husk ash.

2. RESULTS AND DISCUSSION

2.1 ATTERBERGS LIMITS

Table-1 Variation of LL, PL and PI for various proportions of Soil, RHA and Shredded rubber tyre chips

Soil: shredded rubber tyre chips:RHA(%)	Liquid Limit (%)	Plastic limit(%)	Plasticity Index (%)
75:15:10	47.5	30.8	16.7
73:17:10	48.1	29.2	18.9
78:11:11	49.2	28.9	20.3
76:13:11	50.4	27.7	22.7
74:15:11	51.8	26.5	25.3
72:17:11	52.5	25.2	27.3

2.2 Variation of MDD and OMC Values of Various Mix Proportion

Table 2 MMD and OMC for soil-RHA-SRTC MIX

Soil: shredded rubber tyre chips:RHA(%)	MDD (g/cc)	OMC (%)
75:15:10	1.86	16.45
73:17:10	1.80	17.29
78:11:11	1.71	18.98
76:13:11	1.65	19.50
74:15:11	1.60	20.49
72:17:11	1.56	21.71

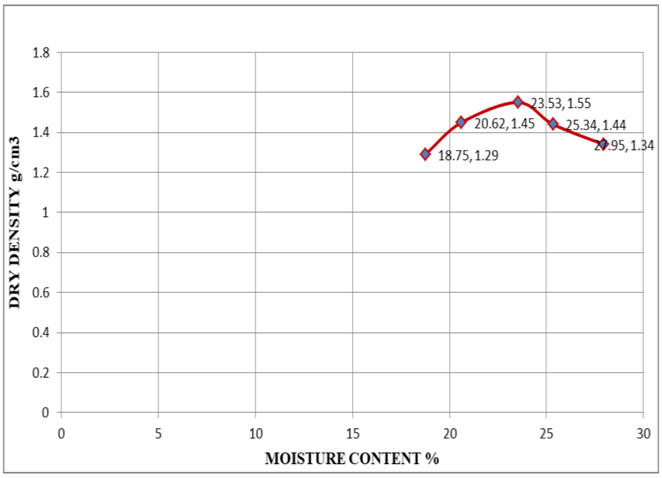

Fig 1: variation in the dry density and moisture content

2.3 UCS

The value of unconfined compressive strength for original soil and soil with various mix proportions of rice husk ash and shredded rubber tyre chips calculated from UCS test is given below:

Table-3: UCS Values Of Various Mix Proportion at Different Curing Periods

Soil: shredded rubber tyre chips:RHA(%)	UCS (kPa) 3days curing	UCS (kPa) 7days curing	UCS (kPa) 28days curing
100:0:0	97	97	97
73:17:10	390	520	670
78:11:11	315	430	540
76:13:11	280	370	424
74:15:11	210	290	380
72:17:11	198	220	270

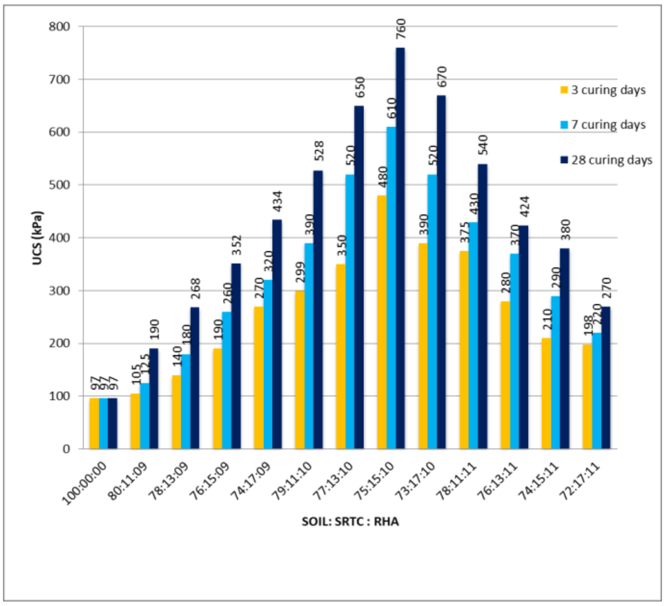

Fig 2 : Unconfined compressive strength of soil with RHA and SRTC

2.4 CBR

California bearing ratio (CBR) value of a soil or stabilized soil is a crucial parameter in depicting the viability of the soil for engineering use. It gives us an idea about the strength and bearing ability of the soil.

The variation of the CBR of soil mixtures with SRTC and RHA contents are given in Fig. 4.9 The CBR gave a peak value at 75:15:10(SOIL: SRTC: RHA).

It was noticed that, though, the value of the CBR showed increment with higher additive contents at higher compactive efforts, the compactive efforts do not have appreciable effect on the values of the CBR.

Table-4: California Bearing Ratio Test Results For SOIL: SRTC: RHA Mixes

S.NO.	Soil : SRTC: RHA	CBR %
1	100 : 0 : 0	2.5
2	75 : 15 : 10	6.5
3	72 : 17 : 11	6.2

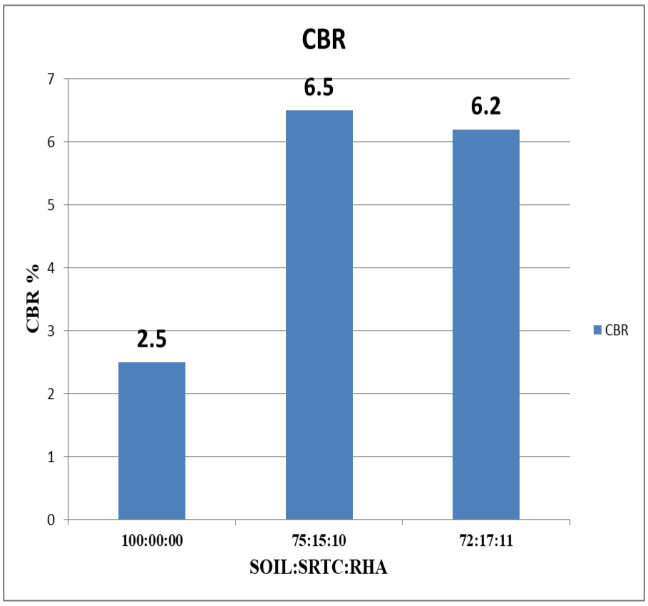

Fig -3: CBR value for different mixes

3. CONCLUSIONS AND FUTURE SCOPE

3.1 conclusions

1. The optimum mix is found to be 75% soil, 15% SRTC and10% RHA on the basis of consistency limit test and compaction test.
2. The values of consistency limits for optimum mix (75:15:10) are found to be as follows, LL=47.5, PL=30.8, PI=16.7.
3. The MDD increases from 1.55 to 1.86 and OMC decreases from 23.53 to 16.45 with increase in percentage of rice husk ash and shredded rubber tyre chips into the soil.
4. The compressive strength of soil from UCS test increases from 97kpa (3days) with the addition of SRTC and RHA till it becomes maximum i.e. 480kpa (3day) for optimum mix (75:15:10) and then goes on decreasing. The same increasing pattern is observed for 7 and 28 curing days.
5. The unconfined compressive strength also increases with the increase in curing days of optimum mix.
6. The increase in compressive strength is due to pozzolanic reaction taking place between lime and silica in presence of moisture.
7. The CBR value is also found to increase from 2.5 with increase in percentage value of SRTC and RHA till it attains maximum value i.e. 6.5 for optimum mix (75:15:10) & the increase in CBR is due to pozzolonic reaction.

3.2 Future Scope

1. In the present study only up to 25 percent replacement of shredded rubber tyre chips by soil has been considered. The other percentages percent need to be investigated.

2. Other types of waste material like stone quarry, plastics, recycled aggregates, polythene bags etc. also need be tried to know the effect of various type of reinforcement.

3. Durability of RHA needs to be checked, by conducting the tests for different curing period.

4. Since the work is on expansive soil with addition of SRTC And RHA, so it shows effective results for the stabilization of expansive soil. In the field of stabilization of sub grades, there is a lot of scope for further work. Similar stabilization can also be done by using various other materials available.

REFERENCES

1. **Piyush V. Kolhe1, Rushikesh V. Langote (2017),** *"Performance of Black Cotton Soil Stabilized With Rubber TyreShreads",* Journal of Geotechnical Studies Volume 2 Issue 2.

2. **Abarajithan. G, Rishab Kumar. P, Srikanth. R (2017),** *"Feasibility of Soil Stabilization using Rice Husk Ash and Coir Fibre"*, International Journal of Engineering Research & Technology (IJERT), Vol. 6 Issue 04, April-2017.

3. **Rathan Raj R, Banupriya S &Dharani R (2016),** "*Stabilization of soil using Rice Husk Ash*"International Journal of Computational Engineering Research (IJCER),ISSN (e): 2250 – 3005 || Volume, 06 || Issue, 02 ||February – 2016.

4. **Phani Kumar Vaddi, D. Ganga, P. Swathi Priyadarsini, Ch. Naga Bharath (2015),** *"experimental investigation on california bearing ratio for mechanically stabilized expansive soil using waste rubber tyre chips"*International Journal of Civil Engineering and Technology (IJCIET) Volume 6, Issue 11, Nov 2015, pp. 97-110, Article ID: IJCIET_06_11_011.

5. **Umar Jan, Vinod K. Sonthwal, Ajay Kumar Duggal, Er. Jasvir S. Rattan, MohdIrfan (2015),** *"Soil Stabilization Using Shredded Rubber Tyre",International Research Journal of Engineering and Technology (IRJET), Volume: 02 Issue: 09 | Dec-2015, e-ISSN: 2395-0056, p-ISSN: 2395-0072.*

6. **Aparna Roy (2014),** *"Soil Stabilization using Rice Husk Ash and Cement"*International Journal of Civil Engineering Research. ISSN 2278-3652 Volume 5, Number 1 (2014), pp. 49-54 © Research India Publications ,http://www.ripublication.com/ijcer.htm.

7. **GhatgeSandeepHambirao ,Dr.P.G.Rakaraddi (2014),** *"Soil Stabilization Using Waste Shredded Rubber Tyre Chips", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 1 Ver. V (Feb. 2014), PP 20-27 www.iosrjournals.org.*

8. **Z. Ali Rahman, H. HasanAshari, A.R. Sahibin, L. Tukimat and I. Wan MohdRazi(2014**),*"Effect of Rice Husk Ash Addition on Geotechnical Characteristics of Treated Residual Soil*" American-Eurasian J. Agric. & Environ. Sci.", 14 (12): 1368-1377, 2014 ISSN 1818-6769 © IDOSI Publications, 2014 DOI: 10.5829/idosi.aejaes.2014.14.12.12462.

9. **Mohammed Y. Fattah, Falah H. Rahil, Kawther Y. H. Al-Soudany (2013),***"Improvement of Clayey Soil Characteristics Using Rice Husk Ash "*Journal of Civil Engineering and Urbanism,Volume 3, Issue 1: 12-18 (2013) ,(Received: December 25, 2012; Accepted: January 28, 2013; Published: February 30, 2013)

IS 2720 (Part V) (1985) —Determination of Liquid & Plastic Limits

IS 2720 (Part VII) (1980) —Determination of Moisture content & Dry Density