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STABILIZATION OF SOIL USING CRUMB RUBBER

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ABSTRACT

Inthis study, the effort of inclusion of waste crumb rubber on the clayey soil has been investigated. Crumb rubber was added to the soil in the proportion of 5%, 10%, and 15% by weight and Unconfined Compressive Strength Tests and California bearing ratio tests are conducted for cohesive soil with 2%, 4% and 6% lime with the varying rubber percentage i.e 0%,5%,10% and 15% and the results were noted and compared. The clay is generally weak and has no stability in heavy loading. With addition of crumb rubber in soil, the study reveals that there is significant improvement in the shear strength bearing capacity of soil and also increases the permeability of soil. It was also observed that there was decrease in Optimum moisture content and maximum dry density with increase in percentage of crumb rubber on soil. There is an improvement over soil properties by increasing percentage of crumb rubber up to 15% is studied by C.B.R. Most importantly, the utilization/disposal of this hazardous waste material reduces its impact on environment and health.

Keywords; Crumb rubber, lime, C.B.R, Optimum moisture content, maximum dry density, Stabilization.

I. INTRODUCTION

Disposal of discarded waste tires is one of the primus problem faced by the industries and government of many countries because it has a momentous share in the solid waste. About 1.5 billion tires has been produced in an year throughout the world and per annum almost 1000 million tires reach the end of their useful life. In India, a phenomenal increase in the number of automobiles has been noticed. In year 2010-11 the total production of tires was 124.3 million and became 146.1 million in the year 2014-15 (ATMA, 2015)

Geotechnical engineers around the world are in search of new alternative materials which are required both for cost effective solutions for ground improvements and for conservation of scarce natural resources. The Industrialization and urbanization have been the two worldwide phenomenon in the present century. The major ill effect of industrial wastes (such as incineration ash, plastic waste, rice husk-ash, waste rubber tires etc.) and the problems related to their safe disposal and management. The safe and profitable disposal of these wastes is one of the greatest challenges before the industries.

The use of waste tires as a fuel is now prohibited by Indian government since 2006 due to its environmental impact. The common practice used for disposal of the waste tire such as stock piles, and fills and burning are considered as a big danger to the health of humans and ecological systems. The stockpiling provides breeding sites for mosquitoes and rodent, whereas heaving of the ground has been faced with landfills disposal of waste tires. The poisonous gases released by the burning of waste tires caused hazards to the population living nearby area.

Therefore, timely action regarding the safe disposal of waste tire is necessary, keeping in view the environmental problems and health hazards associated with it, one of the common and feasible ways to utilize these waste products is to explore their uses in the construction of roads, highways, embankments and a fill material. Tire waste can be used light weight material in the form of powder, chips, shredded and effective in protecting the environment and conserving natural resources.

Now a days construction is also being carried out on marginal sites having extremely poor ground conditions like soft clays that were earlier considered unsuitable due to their poor strength and high compressibility. Such soils, when loaded cause excessive settlements and early failure of structures.

Apart from the environmental benefits of recycling waste tires also has tremendous potential of generating wealth. To address the above concerns crumb rubber powder is an additive to improve the industry. The use of discarded waste tires as an engineering material is gaining popularity among civil engineering fraternity due to its low density, high strength, resilience and high frictional strength, which are essential from the geotechnical engineering perspective.

II. LITRETURE REVIEW

In the present environmental and economic ambiance high pressure are laid on the engineers to identify suitable methods wherever possible to reuse any locally available waste materials in order to minimize the costs 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 tires 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.

The 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 whole tires, shredded and chips or tin mix with soil. The overview has brought out the need for reinforcement. With the same intention literature review is undertaken on utilization of solid waste material for stabilization of soil and their performance.

Baykal et al. (1992) mixed clay with used tire obtained from retarding industry and hydraulic conductivity tests were conducted using water gasoline as permeates. The strength of soil tire powder decreases once the rubber content exceeds 30% in the mixture because soil tire chip mixture behaves less like reinforced soil and more like a fuse chip mass with sand inclusion.

foose (1996) falling head permeability test were conducted on rubber mixed soil samples and it was observed that when water permitted through samples a slight increase in hydraulic conductivity was observed

lee et al. (1999) also determined the shear strength and stress-strain relationship of tire chip and a mixture of sand and tire chips. They found out the stiffness and strength properties for chips shreds and rubber sand mixture.

Papp et al (1997) conducted research shredded scrap tires blended with subbase soils under flexible pavements. Resilient modulus (Mr) testing was used to determine the plastic and elastic strains tests were conducted on cohessionless soil blended with varying amounts of shredded tire chips. Blend ratios ranged from 0.1 to 0.5 tire chips to soil by dry weight. The performance of the shredded tire blends was compared to that of the naturally occurring virgin soil used in sub base applications in New Jersey. He concluded that physically mixing tire chips with the soil did not present any problems except when excessive steel wires were protruding from the chips. The addition of the tire chips to the soil reduced both density and strength of the soil. The 50mm(1.96 inch) tire chips were most economical and had the least negative strength impact.

Rao and Dutta (2001) conducted studies on sand mixed with rubber chips. Compressibility tests and triaxial tests were conducted. The stress strain relations and strength parameters were studied. It was found that the value of internal friction and effective cohesion of sand increased with increase in percentage of rubber upto 15%.

Ghazavi (2004),investigated the suitability of recycled granular rubber as a lightweight backfill material. He observed that the unit weight of the sol was reduced from approximately 14Kn to approximately8 KN original for the 70% rubber blend. Ghazavi concluded that

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

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

Cabalar, (2011),blended GTR with sands from two geologic formation, Leighton Buzzard Sand (LBS) and Ceyhan Sand (CS). These sands were selected for their differences in structure and engineering properties. LBS is coarse with sub angular particles, and CS is fine with angular particles. The rubber parices size was not listed but the particles were described as “flaky.” Rubber was blended with each type of sand at 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 then leveled off. He concluded that the blends were useful as light weight embankment fill on weak foundation soils and retaining wal backfill material since the sand rubber mixtures were significantly lighter than 100% sand mixtures.

III. MATERIAL USED

1. Soil

In this study, clayey subgrade soil is used. Locally available clayey soil was collected from the fields of Shahabad district Kurukshetra at a depth of 0.7m below the ground surface by using technique of disturbed sampling and thoroughly hand sorted to eliminate the vegetative matters and pebbles.

2. Crumb powder

For improving the engineering properties of the clay, crumb rubber was chosen as an additive. Crumb rubber is a term usually applied to recycled rubber from automotive and truckscrap tires. During the recycling process steel and fluff is removed leaving the 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

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further.

The crumb rubber powder, which is used as an additive in the present study for getting the desired engineering properties in the available problem clay.

3. Lime

Lime is used along with the crumb rubber powder in order to enhance the engineering properties of soil. In this study lime is used from the locally available market.

IV. MIXING PROPORTIONS

Clayey Soil, crumb rubber and lime is to be mixed thoroughly to have a uniform and homogenous mixture. Sample will be prepared using different combination of crumb rubber, lime and parent soil and different tests will be conducted on the prepared samples and result will be compared with the original clay sample.

Table (1) Various proportions of sample used

Sample	Soil (%)	Crumb rubber powder (%)	Lime (%)
A	100	0	0
B	93	5	2
C	86	10	4
D	79	15	6

V. TESTING

Proper design and testing is an important component of any stabilization project. This testing will establish proper design criteria in determining the proper additive and admixture rate to be used to achieve the desired engineering properties. It is imperative to solicit the expert advice and engineering knowhow of a certified geotechnical engineer for all soil stabilization work. Having a geotechnical engineer is one of the most important components of a successful project

The following tests were conducted:-+

5.1 Grain Size Distribution

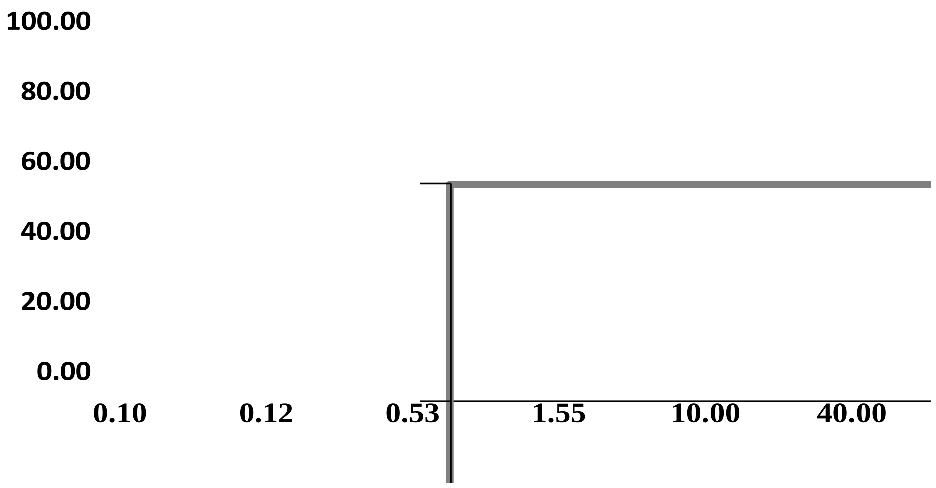

Figure 1 Particle Size Distribution Of Soil

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LIQUID LIMIT OF PARENT SOIL

Table 2 Liquid Limit of Parent Soil

S.N	OBSERVATIONS	DETERMINATION NUMBER		
		1	2	3
1	n. of blows (N)	25	21	17
2	Container n.	P2	P1	P5
3	Water (gm)	52	56	54
4	Mass of empty container (M_1) (gm)	10	10	10
5	Mass of empty container+ wet soil (M_2) (gm)	55	80	60
6	Mass of container+ dry soil (M_3) (gm)	42	60	46

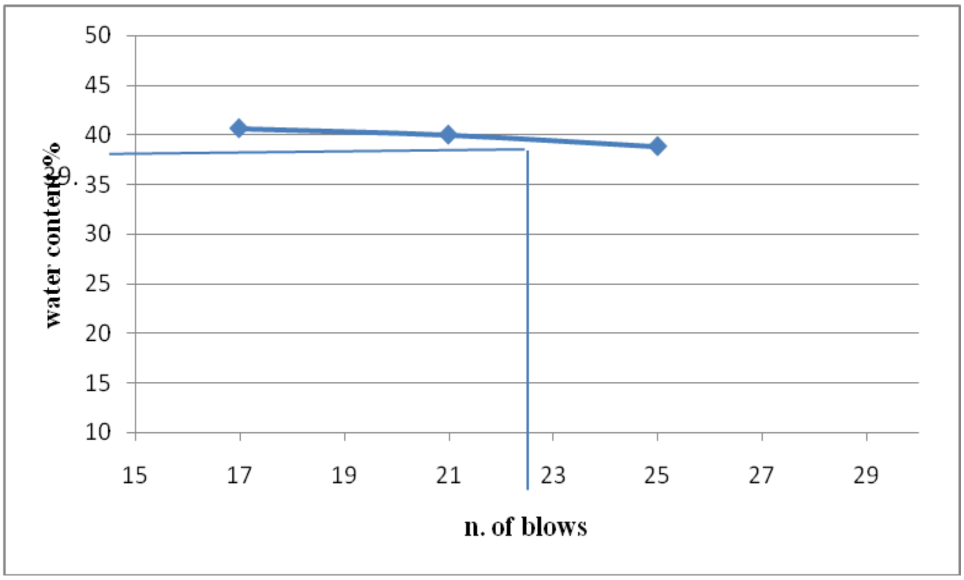

Figure 2 liquid limit of parent soil

6.2. LIQUID LIMIT OF SOIL WITH 15% CRUMB RUBBER POWDER

Table 3liquid limit of soil with 15% crumb rubber powder

S.N	OBSERVATIONS	DETERMINATION NUMBER		
		1	2	3
1	n. of blows (N)	22	18	20
2	Container n.	4	5	6
3	Water (gm)	52	56	54
4	Mass of empty container (M_1) (gm)	26	28	26
5	Mass of empty container+ wet soil (M_2) (gm)	52	46	58
6	Mass of container+ dry soil (M_3) (gm)	46	42	48

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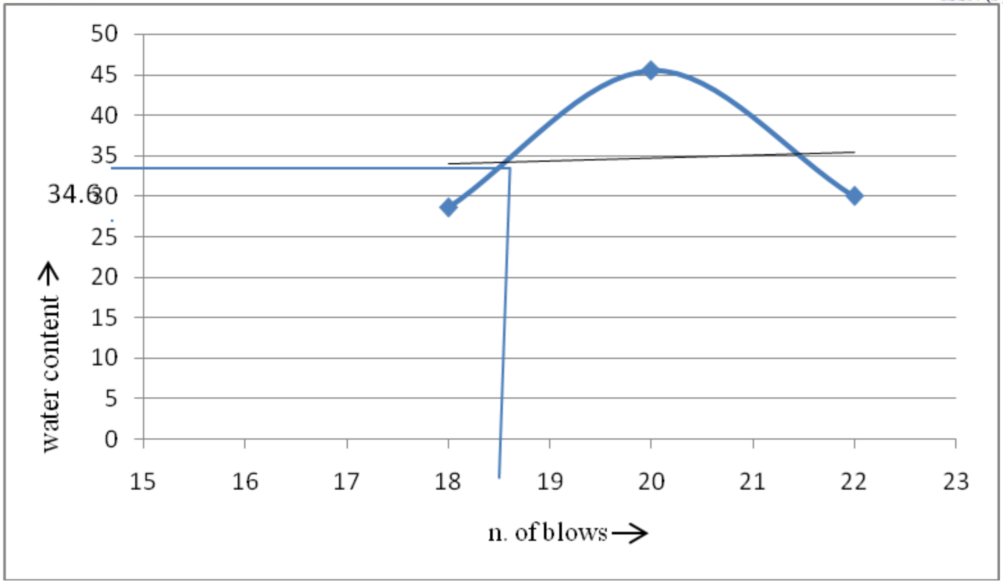

Figure 3 liquid limit of soil with 15% crumb rubber powder

6.3. Compaction Test

Table 4 Compaction test on parent soil

S.N	OBSERVATIONS	DETERMINATION NUMBER		
		1	2	3
1	Mass of mould + base plate (gm)	3760	3776	3692
2	Mass of mould + base plate + compacted soil (gm)	5568	5488	5620
3	Mass of compacted soil (gm)	1808	2048	2057
4	Container number	3	10	2
5	Bulk density	$1.808*10^{-3}$	$0.198*10^{-3}$	$0.168*10^{-3}$
6	Water content (%)	8	10.3	11.2
7	Dry density	$1.674*10^{-3}$	$0.198*10^{-3}$	$0.168*10^{-3}$

6.4. Uncoonfined Compressive Strength Test of Parent Soil

Table 5 UCS test of parent soil

Division	Load(kg)	Deformation		Corrected area	Strain	Compressive stress(kg/cm^2)
0	0	0	0	9.616	0	0
6.7	1.68	50	0.5	9.685	0.00714	0.6917
11	2.75	100	1.0	9.752	0.01428	1.127
13.5	3.37	150	1.5	9.827	0.02142	1.373
16	4	200	2.0	9.888	0.02857	1.618
17	4.25	250	2.5	9.964	0.03570	1.70
17.5	4.35	300	3.0	10.037	0.04285	1.743
18	4.5	350	3.5	10.12	0.05000	1.778
17.5	4.37	400	4.0	10.87	0.05714	1.609
17.1	4.27	450	4.5	11.60	0.06428	1.47

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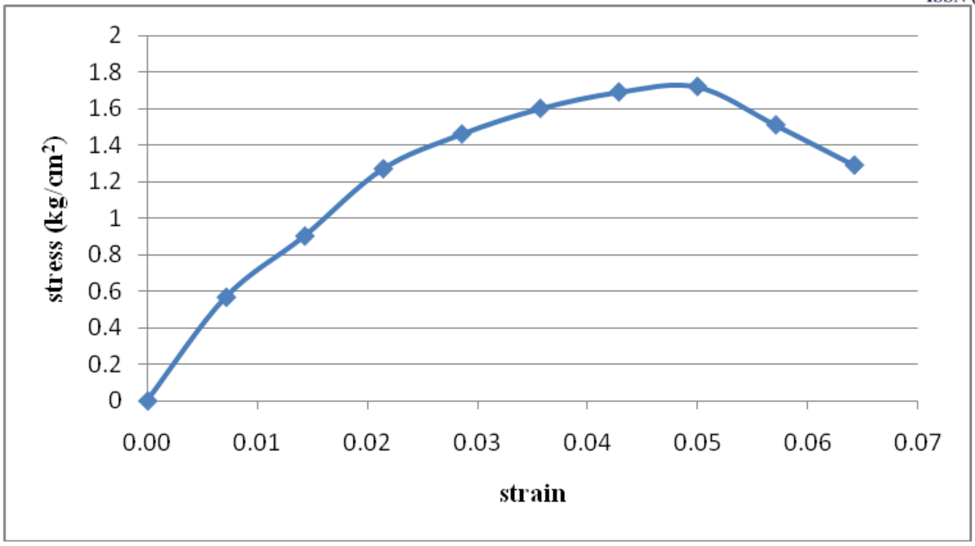

Figure 4 Unconfined Compressive Strength test of parent soil

6.5. Unconfined Compressive Strenth Test for Soil With 15% Crumb Rubber Powder

Table 6. UCStest for soil with 15% crumb rubber powder

Division	Load(kg)	Deformation		Corrected area	Strain	Compressive stress(kg/cm^2)
0	0	0	0	9.616	0	0
8	2	50	0.5	9.685	0.00714	0.826
12	3	100	1.0	9.752	0.01428	1.23
15	3.37	150	1.5	9.827	0.02142	1.52
17	4.25	200	2.0	9.888	0.02857	1.71
18	4.50	250	2.5	9.964	0.03570	1.80
18.6	4.65	300	3.0	10.037	0.04285	1.85
19	4.75	350	3.5	10.12	0.05000	1.87
18.6	4.65	400	4.0	10.87	0.05714	1.71
18	4.50	450	4.5	11.60	0.06428	1.53

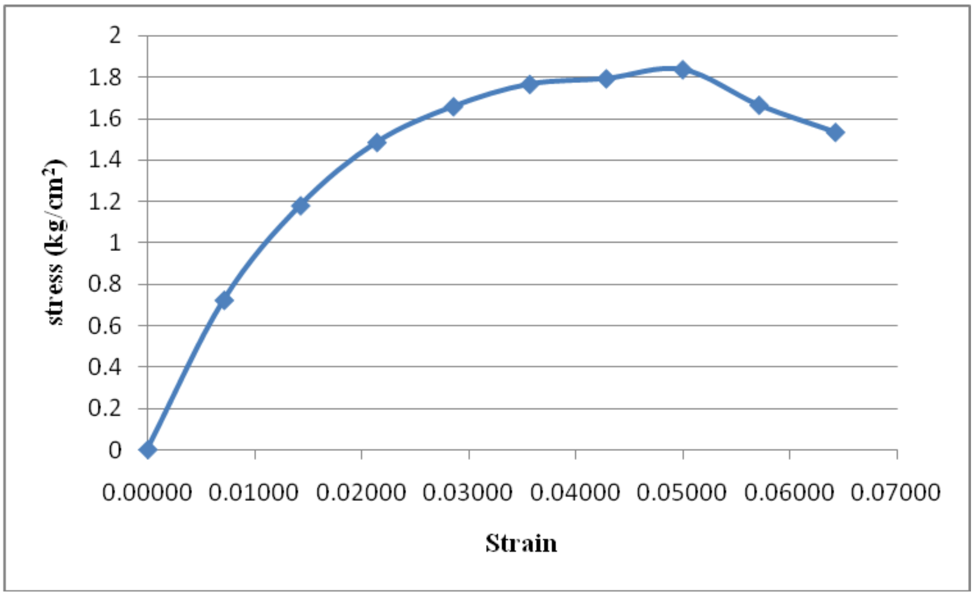

Figure 5 Unconfined Compressive Strength test for soil with 15% crumb rubber powder

6.6. Unconfined Compressive Strenth Test for Soil With 15% Crumb Rubber Powder+4% Lime

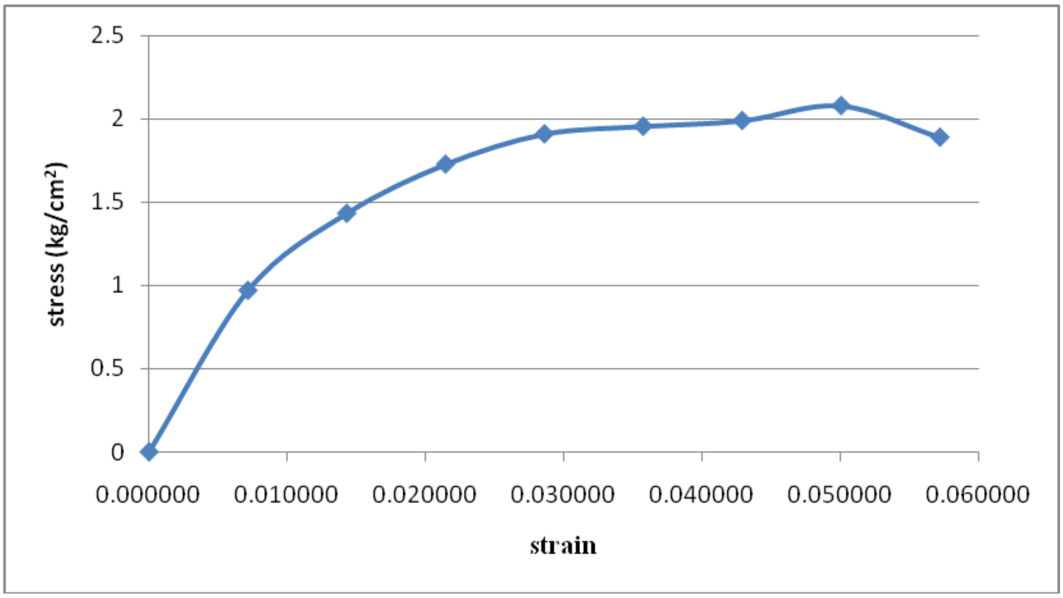

Figure 6 Unconfined Compressive Strength Test for soil with 15% crumb rubber powder+4%lime

VIII. CONCLUSION

On the basis of present experimental study, the following conclusions are drawn:

- The results of modified Proctor test conducted on the various mixtures .The inclusion of rubber in the clayey soil leads to lowering in the maximum dry density (MDD) of clay. For example, the maximum dry density of the clay is 16.35 kN/m^3, which reduces to 1.674 kN/m^{3}to 1.557 kN/m^3 with the addition of 5% to 15% crumb rubber powder.
- The strength of used material is increases with decrease in water content for a particular composition.
- A study reveals that the peak axial stress of clay mixed with rubber increases marginally up to 5% inclusion of crumb rubber, thereafter it starts decreasing.
- Here maximum dry density 1.777 at minimum water content is 16.73.
- The unconfined compressive strength of the clay increases with the addition of cement. It is due to the formation of hydration product in the cemented clay mixture, which leads to the strengthening of the specimens.
- Both maximum dry density and optimum moisture content of the clay decreases with the addition of crumb rubber, whereas inclusion of lime in the rubberized clay leads to decrease in the density and increase the optimum moisture content of the mixtures.
- Rubber powder, crushed mechanically in ambient temperature, showed has a very low density of about 0.83, cohesion varied from 6.5 to 50 kPa.
- The presence of gap between the rubber and cemented clay is an indication of weak interfaces resulting into strength reduction in the composite.
- The use of crumb rubber as a stabilizer introduces a low cost method for stabilization and it significantly reduces the waste tyre disposal problem that currently exists.

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VIII. SCOPE OF FURTHER STUDIES

Due to its objectives, this treatment for the stabilization of expansive soil is will becomes very important for those areas where this kind of problem is facing with the soil and this kind of soil creates a big and blunt problems for the construction of buildings.

- Improvement in stability of soil for the good building construction in civil engineering.
- Making the foundation process cheap and comfortable in economically.
- Observe a right concentration mixture of the additional component like Crumb rubber powder and cement content.
- Use of wastage material which is producing in high potential and having disposal problems.

Above are the main objectives of this experiment which states that the prevention of swelling/shrinkage by this process is comfortable and cost effective.

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