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RESEARCH ARTICLE

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A COMPARATIVE STUDY ON SOIL BEARING CAPACITY OF SOFT SOIL USING SEA SAND AND CRUMB RUBBER AS A STABILIZED MATERIAL

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ABSTRACT

In this experimental work a study was done on the effect of low cost materials as a stabilizer to improve the SBC of the soil. This paper aims to study the effect of sea sand and crumb rubber in different proportions on the SBC of soft clay soil. The stabilized materials used are mixed with soft soil at various percentages (i.e. 0%, 3%, 6%, 9%, and 12%). The optimum percentage of stabilized materials is determined. The basic soil parameters such as compaction, unconfined compression strength and California bearing capacity testing methods were used to gauge the behaviour and performance of the stabilized soils. The UCC and CBR value was studied at the optimum percentage of the stabilized materials are obtained.

Keywords— Crumb rubber and sea sand, soft clay soil, SBC

I. INTRODUCTION

In engineering construction, the problems with soil always occur even during construction or after construction. This happen as the soil cannot reach the required specification such as the Soil Bearing Capacity is too weak to support superstructure built above it. The existing soil at a construction site are not always be suitable for supporting structures such as buildings, bridges, highways, and dams built on it.

Hence, if the building is constructed on the poor soil, many problems will occur after the construction has been finished. The building will be gets damaged because of the settlement of the soil under the structure. Therefore soil stabilization is one of the method of modification (Change in soil properties) of the characteristics of soil in order to enhance the engineering performance of the soil, for example improve the density of soil, mixing the soil with additives to change the chemical and physical properties of soils such as stiffness, compressibility, permeability, workability, lowering the ground water table level and to eliminate weak soil.

II. SUMMARY OF LITERATURE REVIEW

Following observations may be drawn from the broad overview of the literature survey.

- The soil often is weak and has no enough stability in heavy loading. The main aim of the study was to evaluate the scope of stabilization of soil using low-cost methods. Based on literature, sea sand and shredded rubber tire is low-cost and effective to soil stabilization.
- Sea sand is used to improve the density of soil and tire wastes can be used as lightweight material either in the form of whole tires, shredded or chips or in mix with soil.

- The overview has brought out the need for a systematic investigation into the various aspects of stabilization.
- Stabilization using low cost materials especially reinforced earth technique has been gaining popularity in the field of civil engineering due to its highly versatile and flexible nature.
- In the recent years, this technique has been suggested for a variety of geotechnical applications ranging from retaining structures and earth embankments, foundation beds for heavy structures on soft grounds, viaduct bridges and other applications.
- Sea sand and shredded waste tires have many beneficial engineering properties as the sand is used to improve the density and tire waste act as a light weight fill material and when it is used in road base or sub base, shredded tire will improve drainage below the pavement and therefore should extend the life of the road.
- Construction of engineering structures on weak or soft soil is considered as unsafe. Improvement of load bearing capacity of the soil may be undertaken by a variety of ground improvement techniques.
- Sea sand and crumb rubber tire as the reinforcement material for soil subgrade holds great promise. An attempt has been made in this to take up this aspect.

III. EXPERIMENTAL STUDY

3.1 Materials used: The following materials were used in this study

3.1.1 SOFT SOIL Soft soil involved in this study was brought from Mummidivaram, Amalapuram (A.P). The Soft soil is classified as clay of intermediate compressibility of CH (G_s = 2.68 with 76% fines) with expansive behaviour.

TABLE I : SOIL PROPERTIES

Sl No	Properties	Result	Reference
1.	Soil type	CH	IS : 1498 – 1970
2.	Specific gravity	2.68	IS : 2720-3/1-1980
3.	Colour	Black	IS : 1498 – 1970
4.	Fines	76%	IS : 1498 – 1970

Figure 1: Soil sample

3.1.2 SEA SAND: The sand which was used in this study was taken from Kakinada beach area and it was used with and without washing.

Figure 2: Sea sand preparation

3.1.3 WATER: Distilled water was used in the experimental work for mixing of soil and preparation of crumb rubber. The pH value of distilled water taken is 7.0.

3.1.4 WASTE TYRE RUBBER (Powder): Waste tyre rubber was used in the present study. Usually three main categories of discarded tyre rubber have been considered such as

- Chipped rubber
- Crumb rubber
- Ground rubber

In the present study crumb rubber of size 600µ to 300µ are used for the partial replacement of soil. The pieces of tyre rubber was allowed to pass through IS sieves. The particles which passed through 600µ sieve and retained on 300µ sieve are taken.

TABLE II: CRUMB RUBBER PROPERTIES

Type of rubber	Crumb type
Size	600µ to 300µ
Colour	black
Specific gravity	1.09

3.1.5 NaCl FOR TREATING RUBBER: Sodium chloride is one of the form of common salt, table salt etc., is an inorganic compound with the formula NaCl. In present study Sodium chloride solution is used for soaking i.e. for surface treatment of crumb rubber is soaked for 60 days, dried and mixed in soil to improve the frictional properties with soil which enhances the bonding strength between soil and rubber when added it as a stabilizer.

Figure 3: Surface treated rubber

IV. TEST RESULTS

4.0 LABORATORY TEST RESULTS

4.1 RESULTS USING SEA SAND AS A STABILIZER:

4.1.1 LIQUID LIMIT RESULTS: With the addition of sea sand, the results obtained from liquid limit test showing that the water content at liquid limit of soil added without washing of sea sand is lower than that of soil added with washing of sea sand.

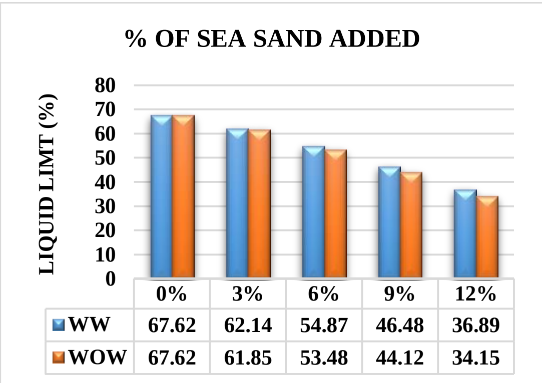


Figure 5: Variation of liquid limit with increase in % of sea sand

From the above graph, it can be observed that the water content of soil in liquid limit with washing of sea sand is decreased when compared with soil without washing.

This is because without washing, the NaCl present in the sea sand helps to improve the bond between sand particles and soil and due to this friction, strength increases between sea sand and soil increases. This results in decrease in water content of soil with addition of sea sand without washing.

The average percentage decrease in water content with washing of sea sand is 11.144 % and average percentage decrease in water content of soil without washing is 12.432%.

4.1.2 PLASTIC LIMIT RESULTS: Results obtained from plastic limit test showing that the water content at plastic limit of soil added without washing of sea sand is lower than the soil added with washing of sea sand.

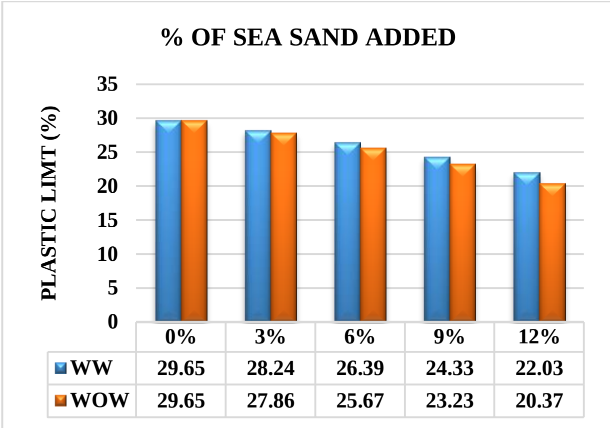


Figure 6: Variation of plastic limit with increase in % of sea sand

From above graph, it can be observed that the water content of soil in plastic limit with washing of sea sand decreased when compared with soil without surface treatment.

This is because without washing, the NaCl which is present in the sea sand reduces or prevents the frost heave that leads to settlement in the soil. By addition of sea sand without washing, NaCl which is present in sea sand lowers the freezing point of water in soil. This results in decrease in water content of soil with addition of sea sand without washing.

The average percentage decrease in water content with washing of sea sand is 5.714% and average percentage decrease in water content of soil without washing is 7.144%.

4.1.3 MDD & OMC

The optimum moisture content (OMC) and maximum dry density (MDD) of the soil varies by increasing the sea sand. It is seen that the OMC decreased with the increase in sea sand with and without washing and MDD increased with the increase in sea sand with and without washing of sea sand.

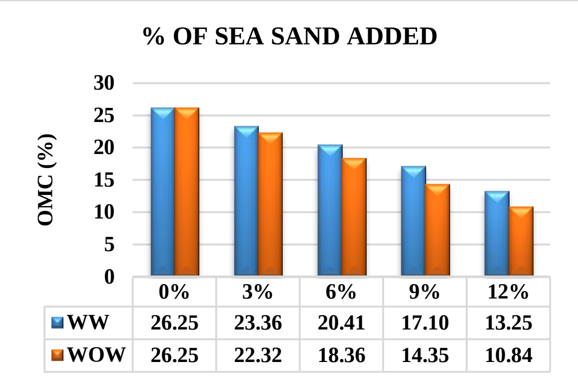


Figure 7: Variation of OMC with increase in % of sea sand

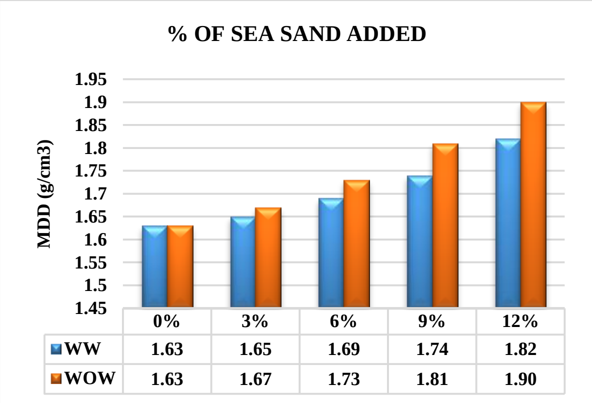


Figure 8: Variation of MDD with increase in % of sea sand

From the above graph it is observed that the maximum dry density increases and optimum moisture content decreases as the percentage of sea sand increases. But, when compared with the surface washed sea sand, the OMC decreases and MDD increases much more in case of sea sand without washing.

The average percentage decrease in optimum moisture content with washing is 12.474% and average percentage decrease in optimum moisture content of soil without washing is 15.802%.

The average percentage decrease in maximum dry density with washing is 2.242% and average percentage decrease in maximum dry density of soil without washing is 3.126%.

4.1.4 FREE SWELL INDEX: Results obtained from free swell test shows that the swelling of soil added without washing of sea sand is lower than the soil added with washing of sea sand.

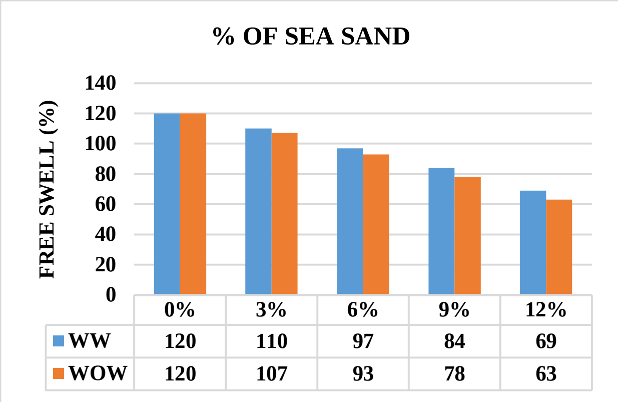


Figure 9: Variation of free swell with increase in % of sea sand

From above graph, it can be observed that the free swell percentage of soil with washing of sea sand decreased when compared with soil without washing of sea sand.

This is because without washing the bond between sand particles and soil is increased. This results in decrease in free swell of soil with addition of sea sand without washing.

The average percentage decrease in free swell with washing of sea sand is 10.282% and average percentage decrease in water content of soil with washing is 11.854%.

4.1.5 CALIFORNIA BEARING RATIO TEST

The CBR percentage increases with increase in percentage of sea sand and it is seen that CBR value increased more when the soil is added sea sand without washing.

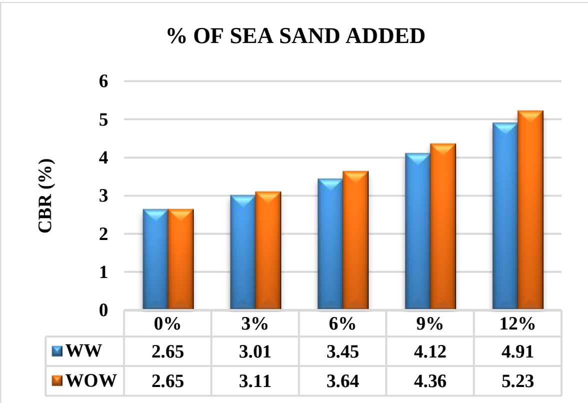


Figure 10: Variation of CBR with increase in % of sea sand

From the above graph it is observed the as the percentage of sea sand added increase, CBR percentage also increases. As the percentage of sea sand with washing increases, that resulted in reduction of CBR percentage of soil. This is because the strength between sand particles and soil is strong when the soil is added sea sand without washing. Hence, when load applied on the specimen, it acts as a hard strata that resists the load applied on it.

The CBR percentage of soil without washing of sea sand is increased with an increase in percentage of sand particles. But these results when compared with washing of sea sand decreased. It is because of without washing of sea sand can develop proper bonding with the soil.

The average percentage increase in CBR of soil with washing is 13.358% and average percentage decrease in CBR of soil without surface treatment is 14.826%.

4.1.6 UNCONFINED COMPRESSIVE TEST

The CBR percentage increases with increase in sea sand and it is seen that CBR value increased more when the soil is added without washing.

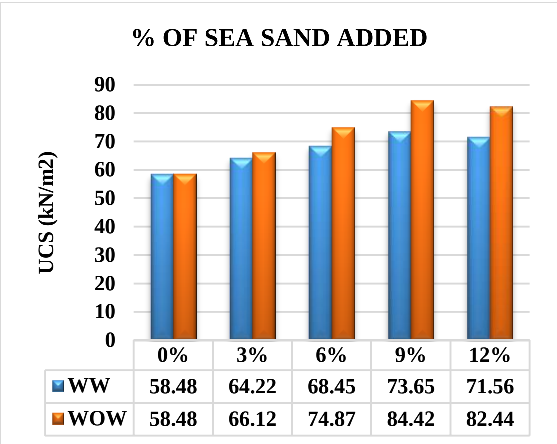


Figure 11: Variation of UCS with increase in % of sea sand

From above graph, it can be observed that as the percentage of sea sand increases, unconfined compressive strength of soil increases upto 9% replacement and further increase of sea sand tends to decrease of compressive strength and specimen gets failed.

But the compressive strength of soil without washing of sea sand is increased than the soil with washing of sea sand. So whenever we are adding sea sand as an additive for stabilizing the soil, better bond formation between soil and sea sand plays a major role in the strength point of view.

The percentage increase in unconfined compressive strength is more in 9% volume replacement of sea sand with and without washing.

The average percentage increase in unconfined compressive strength of soil with washing is 4.234% and average percentage decrease in compressive strength of soil without surface treatment is 7.34%.

4.2 RESULTS USING CRUMB RUBBER AS A STABILIZER:

4.2.1 LIQUID LIMIT RESULTS: Results obtained from liquid limit test showing that the water content at liquid limit of soil added with surface treated rubber is lower than the soil added without surface treatment of rubber.

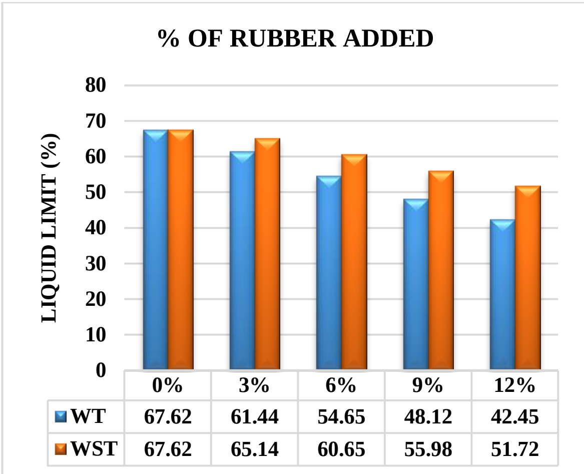


Figure 12: Variation of liquid limit with increase in % of crumb rubber

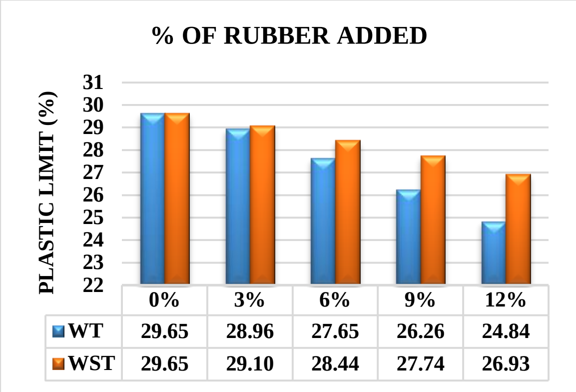
From above graph, it can be observed that the water content of soil in case of liquid limit with surface treated rubber is decreased more when compared with soil without surface treatment.

This is because with surface treated rubber the bond between rubber particles and soil is increased. This results in decrease in water content of soil with surface treated rubber particles.

The average percentage decrease in water content with surface treatment is 8.784% and average percentage decrease in water content of soil without surface treatment is 5.174%.

4.2.2 PLASTIC LIMIT RESULTS

With the addition of rubber to soil the following results were obtained from plastic limit test showing that the water content at plastic limit of soil added with surface treatment of rubber is lower than the soil added without surface treatment of rubber.



	0%	3%	6%	9%	12%
WT	29.65	28.96	27.65	26.26	24.84
WST	29.65	29.10	28.44	27.74	26.93

Figure13: Variation of plastic limit with increase in % of crumb rubber

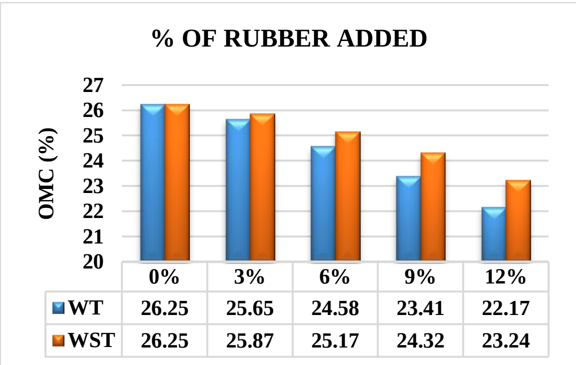
From above graph, it is observed that the water content of soil in case of plastic limit with surface treated rubber is decreased more when compared with soil without surface treatment.

The average percentage decrease in water content with surface treatment is 3.458% and average percentage decrease in water content of soil without surface treatment is 1.90%.

4.2.3 MDD & OMC

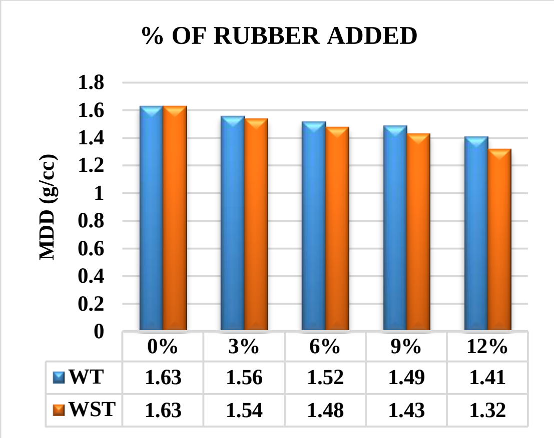
The optimum moisture content (OMC) and maximum dry density (MDD) of the soil decreases with increasing the percentage of rubber content in the soil.

When compared with surface treatment and without surface treatment of rubber, it is seen that the OMC decreased with the increase in rubber content when the soil is added with surface treated crumb rubber and MDD increased with the increase in rubber content with surface treated rubber with NaCl.



	0%	3%	6%	9%	12%
WT	26.25	25.65	24.58	23.41	22.17
WST	26.25	25.87	25.17	24.32	23.24

Figure 14: Variation of OMC with increase in % of crumb rubber



	0%	3%	6%	9%	12%
WT	1.63	1.56	1.52	1.49	1.41
WST	1.63	1.54	1.48	1.43	1.32

Figure 15: Variation of MDD with increase in % of crumb rubber

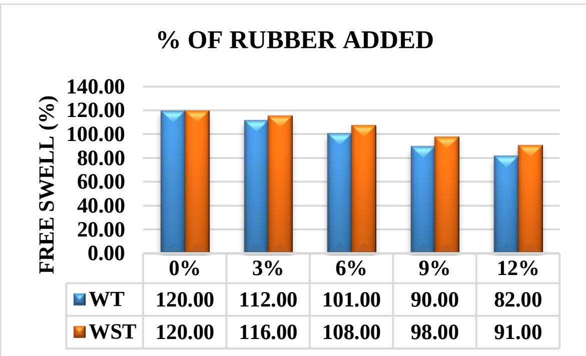
From the above graph, it is observed that the maximum dry density and optimum moisture content decreases as the percentage of rubber increases. But, when compared with the surface treated rubber, the OMC and MDD decreases much more in case of rubber added without surface treatment.

The average percentage decrease in optimum moisture content with surface treatment is 3.304% and average percentage decrease in optimum moisture content of soil without surface treatment is 2.396%.

The average percentage decrease in maximum dry density with surface treatment is 2.838% and average percentage decrease in maximum dry density of soil without surface treatment is 4.098%.

4.2.4 FREE SWELL TEST

Results obtained from free swell index test showing that the swelling of soil added with surface treated crumb rubber is lower than the soil added without surface treatment of rubber.



	0%	3%	6%	9%	12%
WT	120.00	112.00	101.00	90.00	82.00
WST	120.00	116.00	108.00	98.00	91.00

Figure 16: Variation of free swell with increase in % of crumb rubber

From above graph, it can be observed that the free swell of soil in case of soil with surface treated rubber is decreased more when compared with soil without surface treatment.

The average percentage decrease in free swell with surface treatment is 7.254% and average percentage decrease in water content of soil without surface treatment is 5.326%.

4.2.5 CALIFORNIA BEARING RATIO TEST

The California bearing ratio tests were performed in laboratory in accordance with IS 2720: Part 16.

The CBR percentage increases with increase in rubber content of upto 9% and there after it is decreased and it is seen that CBR value increased more when the soil is added with surface treated rubber.

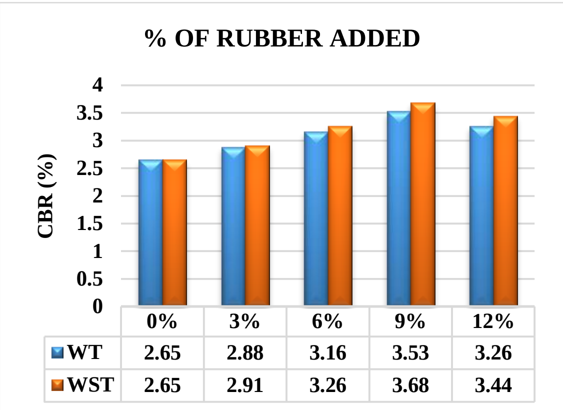


Figure 17: Variation of CBR with increase in % of crumb rubber

From the above graph, it is observed the as the percentage of rubber added increase, CBR percentage also increases. As percentage of rubber increases, that resulted in reduction of CBR percentage of soil without surface treatment of rubber particles. This is because rubber particles are soft in nature, and bonding between rubber particles and soil is strong to some extent.

The CBR percentage of soil without surface treated rubber particles increased with an increase in percentage of crumb rubber. But these results when compared with surface treated crumb rubber increases much better. It is because of surface treatment of rubber particles, the rubber can develop proper bonding with the soil.

The average percentage increase in CBR of soil with surface treatment is 4.492% and average percentage increase in CBR without surface treatment is 5.64%.

4.2.6 UNCONFINED COMPRESSIVE TEST

The UCS value increases with increase in rubber content but, it is seen that UCS value increased much more when the soil is added with surface treated rubber.

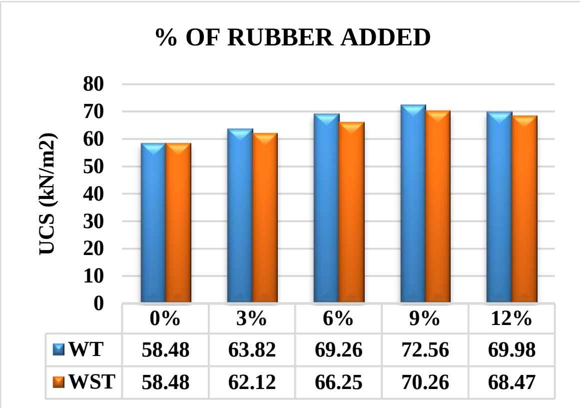


Figure 18: Variation of UCS with increase in % of crumb rubber

From above graph, it can be observed that as the percentage of rubber content increases, unconfined compressive strength of soil decreases. This is an important point to keep in mind that rubber particles when added to soil results in drastic decrease of compressive strength even if we do surface treatment with NaCl.

But the compressive strength of soil with surface treated crumb rubber increased than the soil added with crumb rubber without surface treatment of rubber. So whenever we are dealing with rubber as a stabilizer and selecting suitable agents for better bond formation between soil and rubber plays a major role in the strength point of view.

The percentage decrease in unconfined compressive strength is more in 9% volume replacement of rubber with and without surface treatment. The average percentage increase in unconfined compressive strength of soil with surface treatment is 3.77% and average percentage increase in compressive strength of soil without surface treatment is 3.27%.

V. CONCLUSIONS

- With the addition of sea sand with washing to soil, it has been observed that there is 11.144% reduction in liquid limit, 5.714 % reduction in plastic limit, 12.474% decrease in Optimum Moisture content, 2.242% increase in maximum dry density, and there is an average increase in strength of about 13.358% and 4.234% in CBR and UCC.
- With the addition of sea sand without washing to soil, it has been observed that there is 12.432% reduction in liquid limit, 3.458 % reduction in plastic limit, 15.802% decrease in Optimum Moisture content, 3.126% increase in maximum dry density, and there is an average increase in strength of about 14.826% and 7.34% in CBR and UCC.
- With the addition of rubber particles with surface treatment to soil, it has been observed that there is 8.784% reduction in liquid limit, 3.458 % reduction in plastic limit, 2.838% reduction in maximum dry density, 3.304% decrease in Optimum Moisture content and there is an average increase in strength of about 4.492% and 3.77% increase in CBR and UCC.
- With the addition of rubber particles without surface treatment to soil, it has been observed that there is 5.174% reduction in liquid limit, 1.90 % reduction in plastic limit, 4.098% reduction in maximum dry density, 2.396% decrease in Optimum Moisture content and there is an average increase in strength of about 5.64% and 3.27% increase in CBR and UCC.
- From the results it can be concluded that sea sand and crumb rubber can be effectively used as a stabilizer to improve the soil properties at low cost.
- From the results, it can be concluded that the soil added with sea sand when compared with crumb rubber have improved SBC which can take heavy loads and reduction of maximum dry density and optimum moisture content.
- It was observed from practical consideration that the permeability is reduced when rubber is added to soil.
- Due to satisfied compressive strength results, both the materials can be used in light as well as heavy structures located in regions of urban areas and also used as a pavement material.

VI. REFERENCES

1. Effect of common salt (NaCl) on Engineering Properties of Black Cotton Soil- Prakhar Dubey and Rajesh jain (Jabalpur Engineering College, Jabalpur (M.P) volume-2, issue-2, July 2015
2. Soil Mechanics and Foundation Engineering by Arora, Standard Publishers and Distributors, Delhi
3. Influence of sand and fly ash on clayey soil stabilization Chavali Rama Vara Prasad, Dr. R. K. Sharma, Department of Civil Engineering, National Institute of Technology, Hamirpur, Himachal Pradesh, India. ISSN: 2278-1684, p-ISSN: 2320-334X
4. Das, B.M.,(1999) Principles of Foundation Engineering ,6th edition (Indian edition) Thomson Engineering.
5. "Effect of inclusion of crumb rubber on the unconfined compressive strength and wet-dry durability of cement stabilized clayey soil" prepared by Jitendra Singh Yadav, Suresh Kumar Tiwari.
6. "Geometrical prepared from waste tires, soil and cement" prepared by Panu Promputthang koona, Bancherd Karnchana chetanee.
7. "Soil Stabilization Using Waste Shredded Rubber Tyre Chips" prepared by Ghatge Sandeep Hambirao, Dr.P.G.Rakaraddi. e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 1 Ver. V (Feb. 2014), PP 20-27.
8. "Geotechnical Properties of Problem Clay Stabilized with Crumb Rubber Powder" prepared by Purushotham G. Sarvade and Prashant R She. Vol. 2, No. 4, December 2012
9. Soil Mechanics and Foundations by B.C.Punmia, Ashok Kumar Jain and Arun Kumar Jain, Laxmi, publications Pvt. Ltd., New Delhi.
10. "Application of Tire chips in reinforcement of soil" prepared by Karma Hissey Lepcha, Arvind Kumar Agnihotri, Akash Priyadarshee, and Manish Yadav. ISSN: 2349-8404; Online ISSN:

2349-879X; Volume 1, Number 5; August, 2014 pp. 51 – 53
11. "A Review on the Soil Stabilization with Waste Materials" prepared by Mandeep Singh, Anupam Mittal. (IJERA) ISSN: 2248-9622, (AET-29th March 2014)
12. Geotechnical Engineering by C.Venkataramaiah, New Age Publications.
13. "Stabilization of Soft Soils Using Salts of Chloride" by Hassnen Mosa Jafer. No.(5)/ Vol.(21): 2013
14. "Geotechnical Properties of Rubber Tires and Sediments Mixtures" by Hamid Sellaf, Habib Trouzine, Mouloud Hamhami, Aissa Asroun (Civil Engineering Department, Djillali Liabes, University of Sidi, Bel Abbes, Algeria) Vol. 4, No. 2, 2014, 618-624
15. Soil Mechanics and Foundation Engineering by Arora, Standard Publishers and Distributors, Delhi
16. "Ground Tire Rubber as a Stabilizer for Subgrade Soils" by- Paul Cosentino, Ph.D., P.E. Florida Institute of Technology, Department of Civil Engineering. May- 2014