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# Cohesive Soil Stabilization Using Waste Tyre Crumbs

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**ABSTRACT:** Nowadays, we are witnessing heavy traffic in big coastal cities because of rapid urbanization in these places. The construction of coastal roads helps us to solve the problems of traffic congestion in these cities. It also helps in reducing the travel time, thereby reducing the fuel cost too. Most of the coastal region are filled with cohesive soil. Here, We are explaining cohesive soil stabilization using the scrapped rubber tyres, which solves many environmental problems too. This study introduces an attempt to utilize rubber crumbs from scrap tyres as an environmentally friendly and sustainable additive for soil stabilization and soil reinforcement.

**KEYWORDS:** Waste tyre crumbs, Cohesive soil, CBR.

## I. INTRODUCTION

The number of coastal road projects are increasing these years, to avoid traffic congestions in coastal cities and to minimize the travelling time between the coastal cities. The number of vehicles in urban cities are increasing rapidly because of higher per capita income than the rural places. Due to the increased number of vehicles, more and more tyres are being dumped illegally. As the tyres are highly durable and nonbio-degradable products, It causes lots of environmental issues in the places where it is dumped illegally.

The coastal region is mostly covered with cohesive soil. In these places, water escapes from the soil voids which gradually reduces the volume of the soil available. It may cause settlement of the soil. To avoid such settlement, we need to stabilize the soil. In this research, we attempt to stabilize the cohesive soil in the coastal region using waste tyre crumbs which was previously being dumped illegally. By recycling and reusing the waste tyres, we can safeguard the eco-sensitive coastal areas from pollution and other environmental hazards caused by these tyres. It is also intended to study the behaviour of cohesive soil with and without the addition of various percentage of tyre crumbs, and to study the strength of soil in terms of CBR and to compare it with that of soil stabilized with waste tyre crumbs.

## II. RELATED WORK

Jagtar Singh and Er. Jasvir Singh Rattan (2016) explained the method used to improve the soil property called as soil stabilization. D S V Prasad, A. Venkata Ratnam (2016) in this paper explained about using waste tyres in different forms to reinforce the soil by various applications ranging from retaining structures and earth embankments. Deepanshu Solanki and D.G.M Purohit (2017) investigated of swelling nature of soil or low bearing capacity of soil, and found that the improvement of soil is necessary. Mohammed Abdullateef Al-Neami (2018) investigated and found that the specific gravity, dry density and optimum moisture content decreases with the addition of tyre crumbs to sand. Jagtar Singh and Prof. Vinod Kumar Sonthwal (2017) explained in this paper that the soil is not capable of bearing the load in opposing conditions which leads to failures. Within the data collection period, we had studied about the soil stabilization. Though the studies gave the importance and evidences on the benefits of tyres when mixed with soil, the effect of the soil density and optimum of tyre content needs further study.



III. METHODOLOGY

In order to find the recent state of practice for soil stabilization, Literature search and review was conducted. Engineering properties of soil was determined. The soil was mixed with different proportions of tyre crumbs and tyre powder to obtain an optimum value of mix proportion, so as to give the higher strength characteristics. The cohesive soil is taken from a marshy land at Munnambam, Ernakulam district of Kerala state. The natural water content of the soil is about 10.5%. The engineering properties of the soil were studied in detail as per Indian standard ie. IS: 2720 and the soil was classified as cohesive soil. Tyre crumbs of approximately square and rectangular shapes cut from heavy vehicles tyres passing IS 2.36mm sieve and retained in IS 1.18mm sieve and tyre powder scrapped from light motor vehicle tyres passing IS 600µ sieve, IS 300µ sieve are used in the study. Following steps were conducted for the completion of project:

- (a) Soil sample was collected from Munnambam, Ernakulam
- (b) Basic properties of soil was found
- (c) Compaction characteristics was found
- (d) Different tyre crumbs of different size were added
- (e) Optimum tyre percentage and optimum tyre size was found.

IV. EXPERIMENTAL RESULTS

SIEVE ANALYSIS TEST FOR FINE GRAINED SOIL :

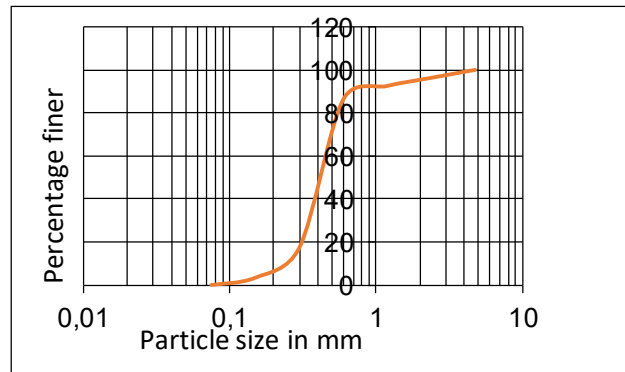


Fig.1. Particle size distribution curve

From Particle Size Distribution Curve for Cohesive Soil, Uniformity coefficient ( $C_u$ )= 2.2 and Coefficient of curvature ( $C_c$ )= 1.09.

LIQUID LIMIT ANALYSIS OF COHESIVE SOIL :

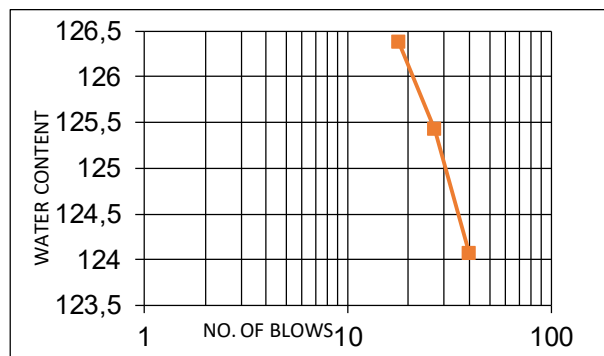


Fig.2. Flow curve



From flow curve the liquid limit is 135 and flow index ( $I_f$ ) is 17.59. Plastic limit of soil is 62.11. The plasticity index ( $I_p$ ) is 72.88 and the toughness index ( $I_t$ ) is 4.14. Shrinkage limit of soil is 49.1

DETERMINATION OF MOISTURE CONTENT AND MAXIMUM DRY DENSITY USING STANDARD PROCTOR TEST:

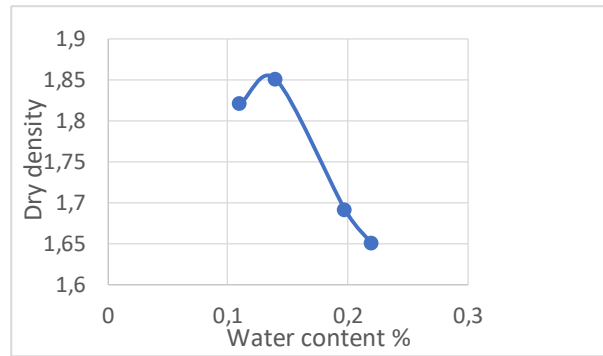


Fig.3. Compaction Curve

From Compaction Curve for Cohesive Soil, the maximum dry density of soil is  $1.866\text{g/cm}^3$  and optimum moisture content is 13%.

UNCONFINED COMPRESSION TEST:

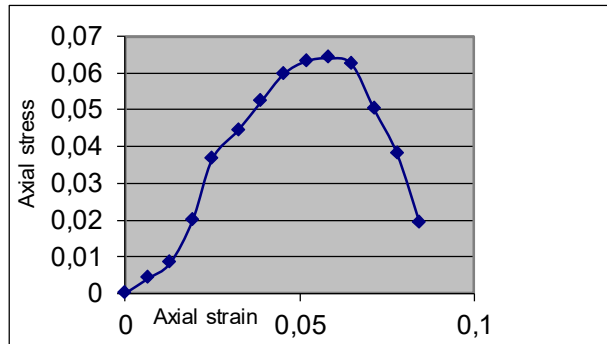


Fig.4. Unconfined Compressive strength

The unconfined compressive strength for untreated soil is  $64\text{g/cm}^2$  and cohesion is found to be  $32\text{g/cm}^2$ .

DETERMINATION OF CALIFORNIA BEARING RATIO:

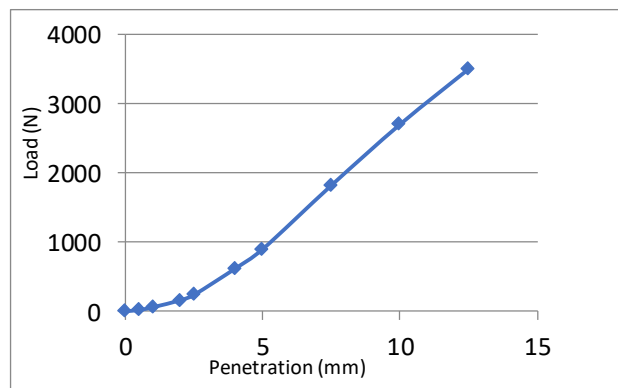


Fig.6. Load Penetration Curve



From load penetration curve, the CBR value for untreated soil is 7.19%.

A series of proctor compaction tests, California Bearing Ratio tests and unconfined compressive tests have been carried out on soil mixed with tyre waste.

**PROCTOR COMPACTION TEST (IS 2720: Part VII: 1980)**

Effect on Dry Density on Various Tyre Percent

**Category 1 –COMPACTION TEST WITH TYRE CRUMBS PASSING THROUGH 600µ IS SIEVE :**

A series of standard Proctor tests are carried out on the soil sample with 0.5% to 3% by weight of tyre powder passing through 600µ IS sieve.

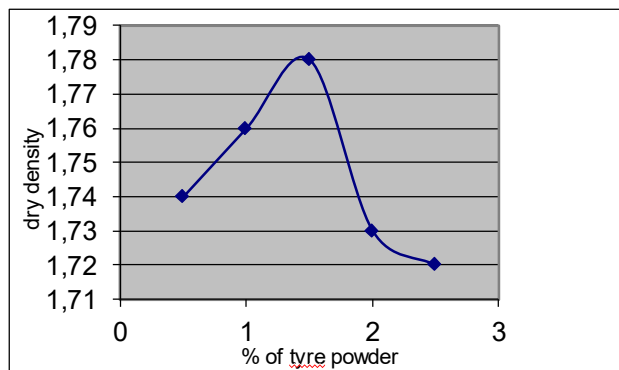


Fig.7. Compaction Curve for Category 1

From Compaction Curve for Category 1. The maximum dry density and optimum tyre percentage for this category of soil is 1.86g/cc and 1.5%. The maximum dry density 1% increased. Category 2 - Compaction test with tyre powder passing through 300µ IS sieve. A series of standard Proctor tests are carried out on the soil sample with 0.5% to 3% by weight of tyre powder passing through 300µ IS sieve.

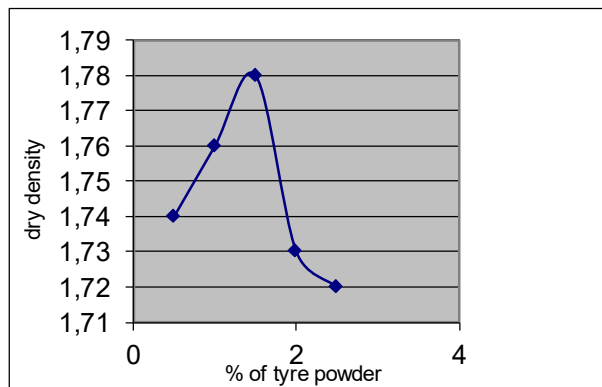


Fig.8. Compaction Curve for Category 2

From Compaction Curve for Category 2, The maximum dry density and optimum tyre percentage for this category of soil is 1.73g/cc and 1.5%. The maximum dry density 12% decreased. Category 3 - Compaction test with tyre crumbs passing through 2.36mm IS sieve and retaining 1.18mm IS sieve. A series of standard Proctor tests are carried out on the soil sample with 0.5% to 3% by weight of tyre crumbs passing through 2.36mm IS sieve and retaining 1.18mm IS sieve.

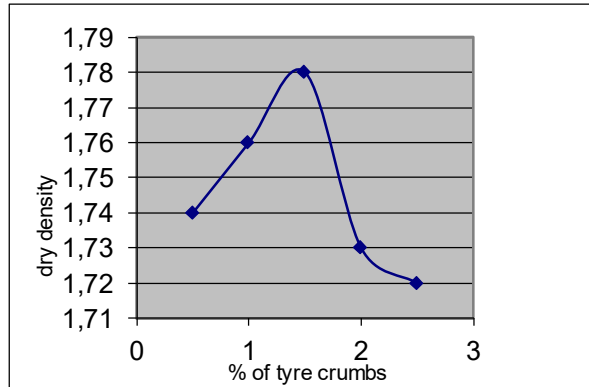


Fig.9. Compaction Curve for Category 3

From Compaction curve for category 3, The maximum dry density and optimum tyre percentage for this category of soil is 1.78g/cc and 1.5%. The maximum dry density 7% decreased.

Category 2 - CALIFORNIA BEARING RATIO TEST (IS 2720: Part 16:1987) :

Effect on California Bearing Ratio (CBR) Category 1 – CBR test with optimum tyre size and optimum tyre percentage The CBR values are increased 2% while adding tyre crumbs. The optimum value of tyre waste content is 1.5%.

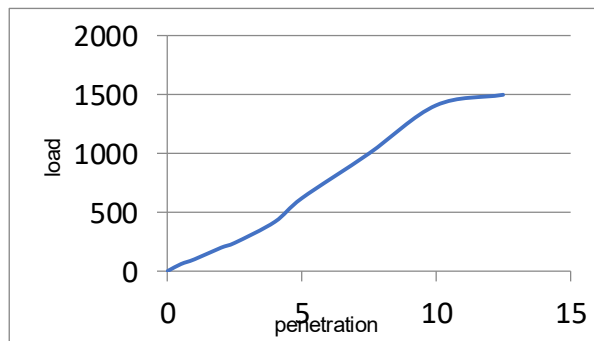


Fig.10. Load Penetration Curve for Category 1

From Load Penetration Curve for Category 1 {description about values} 18% increased

Category 3 - UNCONFINED COMPRESSIVE STRENGTH TESTS (IS-2720: Part 10:1986) :

Effect on Unconfined Compressive Strength (UCS)

Category 1 - UCC test with optimum tyre percentage and optimum tyre size

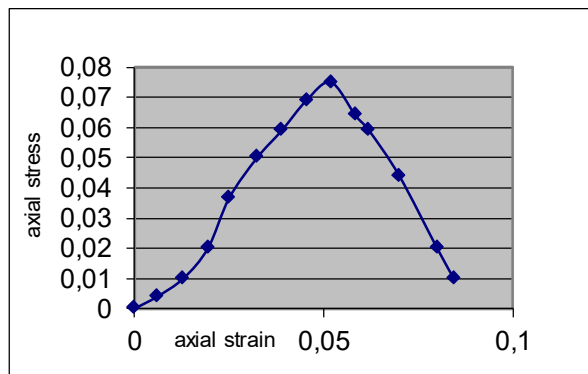


Fig.11 Axial Stress Strain Curve for Category 1



From Axial Stress Strain Curve for Category 1, the compressive strength value is  $75\text{g/cm}^2$ , at optimum percentage of tyre waste of 1.5%. Compressive strength may increase by 17%.

#### V. CONCLUSION

In compaction test with tyre powder, maximum dry density decreases with increasing percentage of tyre powder. The CBR values are increased 2% while adding tyre crumbs. The optimum value of tyre waste content is 1.5%. The increase in the CBR value is due to the reinforcing characteristics of the rubber crumbs. UCC tests are carried out on the soil sample with optimum tyre percentage and optimum tyre size, results showed that the tyre waste mixture could effectively improve the strength of subgrade. Compressive strength may increase by 17%. By using waste rubber tyre crumbs, we can improve stability of soil.

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